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GAS JOURNAL

LIGHT ✦ HEAT ✦ POWER ✦ BYE-PRODUCTS

[Founded in 1849 as the "Journal of Gas Lighting."]

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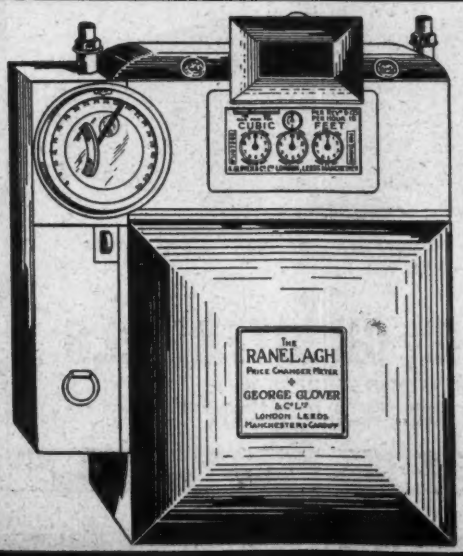

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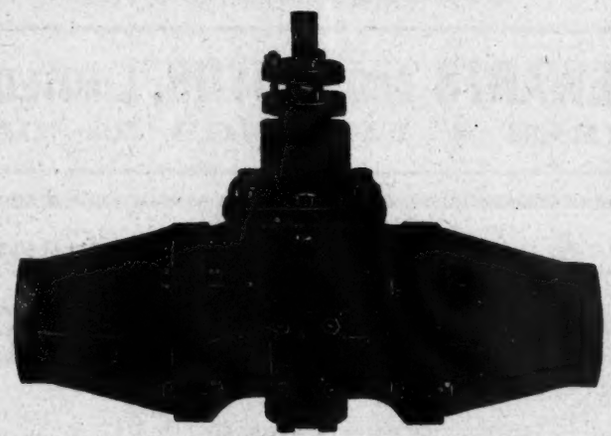

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EDITORIAL NOTES.

Appointments and Qualifications of Gas Examiners.

FOR the information of local authorities and quarter sessions, the Gas Referees have issued a memorandum on the appointment, qualifications, and duties of gas examiners under the Gas Regulation Act. This document is published *in extenso* in later columns. It is a statement drafted in a form and manner that will afford useful guidance to those who are responsible for the selection and appointment of these officials. In this matter of gas testing under the Act and the heat-unit basis of trading, the administrators of gas undertakings are as desirous as anyone of getting into a state of absolute efficiency. Whether they are companies or local authorities, the testing of the gas will be of the highest importance to them; and therefore those on whom the Act has imposed the duty of making the appointments of examiners, who will have to comply with the prescriptions of the Gas Referees, have been invested with a responsibility which, it is hoped, will be taken very seriously. Supplying and charging for heat units, with the testing provided for by the Act, afford excellent security for both gas consumers and gas suppliers, provided the gas examiners have the necessary competence and are impartial. Hitherto, save in the Metropolitan area, and some important centres, gas testing has been carried on in a more or less indifferent and irregular way; but now we are to have systematic testing in every statutory gas-supply district. This will be an advantage. It cannot fail to give public confidence; and public confidence is an inestimable factor in our industrial prosperity. When a consumer is satisfied by unimpeachable testimony that he is obtaining what he pays for, this means comfortable business relations; and such relations are beneficial all round.

It will be noticed that the memorandum is addressed not only to local authorities upon whom devolves the duty of appointing gas examiners, but to quarter sessions; and county councils have also an interest in the document. The Gas Referees lay strong emphasis on the qualifications of the examiners being such "as to inspire the confidence of the "public and of the managements of gas undertakings." In this regard, having in view the "inspiring" of public confidence, it is a pity that, where the gas suppliers are local authorities, the appointment of examiners is not entirely shifted from them, and made a function of the county council or quarter sessions. We have no fear that gas-supplying local authorities will appoint persons who are incompetent and not impartial; but among the public there is a complex mass of opinion, there are cynics, and there are those who are incredulous of even municipal gas suppliers being altogether virtuous. There would thus, in our judgment, be greater certainty in the inspiring of public confidence by the selection and appointment of gas examiners being the duty of some other body than the municipal gas suppliers themselves. Mention is made in the document of the fact that examiners may be jointly appointed by a number of authorities, who will make their own agreements as to expenses and payments. The work of the examiners in testing for calorific value, purity, and pressure will be subject to the prescriptions of the Gas Referees.

The work will also be of a responsible order for the examiners. It is not something that can be done in any perfunctory manner. That is why so much stress is laid by the Referees upon the qualifications of competence and impartiality; and impartiality here covers integrity. The memorandum will be particularly useful in this connection for the counsel and advice it gives. The Referees, none better, know the character of the qualifications essential for this work. Competence in a gas examiner is built upon a knowledge of fundamentals; and so the Referees consider it is important that the gas examiner should have sufficient knowledge of physics and chemistry to enable him to understand thoroughly the tests to be applied to the gas. This is the first essential to be borne in mind when making selection. Then it is also necessary that the person appointed should be accustomed to make quantitative measurements, the accuracy of which he will be able to sustain under cross-examination. The Referees indicate where the persons they have in mind may be sought. Analysts or engineers with experience of physics and chemistry would be suitable. Then we have the already quoted and all-important declaration that the qualifications of the examiner must be such as to inspire the confidence of the public and of the management of gas undertakings. If it were not for the liberty to make joint appointments, we are afraid there would not be sufficient competent men to go round, who could give the time necessary to the proper performance of the work. It is quite plain that incompetents may save themselves the trouble of applying for these appointments; for the Referees have well-established views—views formed from knowledge and experience—as to what is required in a gas examiner. The Referees are out for efficiency combined with economy; and in this the competency of the examiner will have an important part. On the point of economy, there will be satisfaction in noting that the Referees are determined to avoid needless duplication of testing-places and overlapping of the work of examiners; and they are very favourable to joint appointments, which, in suitable cases, it is preferable should be made by county councils. The Referees promise that, in formulating their prescriptions for particular undertakings and areas, they will try to provide for the full economical advantages of such arrangements being reaped.

There is no need to define "impartiality;" but the Referees, it will be observed, are anxious to avoid suspicion of bias on the part of a gas examiner. The administrators of gas undertakings want men appointed as examiners who take a broad view of their duties, and are conscientious. Some men, directly they receive a public appointment of this kind, have a distinct leaning towards the local authority who make the appointment, and get into the bad habit of regarding themselves as watchdogs set to catch a gas company napping. We are sorry to say there has been evidence of this sort of thing in the past. We do not want it under the new order of things. The gas examiner who holds the scales evenly as between a gas undertaking and the consumers is as helpful to the former as he is protective of the latter. Examiners are wanted who will appreciate that the gas industry is entering on a new system, that they themselves will be an essential part of the system, and that in all innovations of this kind time is required to reach perfection. We will not here labour the point. The Referees, however, suggest the undesirability of an examiner being in the employ of the undertaking the gas of which he has to test, or have any financial interest in it. We will go further and say that neither should an employee of a local authority be appointed in any circumstances to the position, even though in a department outside a municipal gas undertaking. And, with equally strong reason, this applies where the gas suppliers are a company. But we hope financial interest in gas companies other than those whose gas is to be tested will not be a disqualification to able engineers and chemists, because there are several capable men who could undertake

the work, and are gas shareholders. The proposal is noticed that deputies, with the same qualifications as the examiners themselves, should be appointed to act in the temporary absence of the gas examiners. This would add to the expense. We can see no reason why, instead of appointing deputies, examiners in neighbouring areas could not make arrangements among themselves for acting as deputies in the event of holidays and temporary absence through illness or other causes.

The memorandum contains an indication as to the number of visits which, in the opinion of the Referees, would be desirable in the case of works of different magnitude. We should not like to say at present that experience will endorse the suggested visiting time-table. It is, however, only a suggestion. As to the length of each visit, we know that in the South Metropolitan Gas Company's area, under the temporary provision made for testing there until the work and apparatus get on a settled basis, the time occupied in the making of tests is much more than two hours. There are also factors for consideration—such as the checking and adjustment of recording calorimeters, which, as at present known, require fairly constant supervision and adjustment in order to prevent the cumulative effect of inaccuracies. It is patent that the Referees are looking (and they are justified in looking) for advances in the design and construction of the apparatus that will be required; but, at the initial stage, we think it would be better not to estimate too finely the requisite time for testing, as too great economy in this direction might prove detrimental. However, the memorandum is timely; it contains good counsel; and it is a highly valuable guide in connection with the change which is coming over the gas industry. It is obvious that the Referees are anxious to do their part in making the change a success, and so an advantage to both the community and the gas industry.

Nearing the End of the Coal Strike.

ONE of the greatest surprises to the extremist leaders of the miners is that the nation has been able to endure a coal stoppage for three months, despite the vast amount of destruction and difficulty that has been caused by it. Now the end of the strike is near, notwithstanding the results of the incomplete ballot of the miners, which ballot was taken much too late, and without any guidance for the men from headquarters. The fact that the end was approaching was proclaimed by Mr. Frank Hodges, the Secretary of the Miners' Federation, in a speech last week at the conference of the Labour Party at Brighton. He said as openly as one in his position could do that the strike had been a failure, that the miners had been defeated, and that the stoppage could not go on indefinitely. He was very eloquent on the solidarity the miners had shown, which solidarity was not disclosed by the ballot figures in relation to the numerical position of the membership of the Federation. But all the well-rounded periods he employed would not disguise the fact that the leaders themselves recognize that their political adventure has come to naught. He spoke (as we have said) of the miners being defeated. The miners have not been defeated in any matter which was a legitimate cause for them to take up; they have only been defeated over questions which were illegitimate. As a matter of fact, if the miners had not rejected the proffered terms and subsidy, we should have looked upon the issue as a success for them, and a defeat for the leaders who closed the door against reason and negotiation, and who desired to establish a new policy, introducing a national pool for the maintenance of the miners' wages, and making permanent the treatment of the whole of the coalfields throughout the country, with all their variations and peculiarities, as one thing. That is the truth of the matter. A further fact is that the miners, simply the puppets of the extreme leaders, were not consulted in any sufficient manner upon these fresh lines of policy; and they simply did what they were bidden to do. This sort of thing is called by Mr. Hodges loyalty and solidarity. It may be loyalty to a union largely dominated by men of advanced views; it is anything but loyalty to one's own intelligence. However, the realization of these things has failed by industrial means, and so Mr. Hodges tells the country that something it is determined not to have will be sought for by other means. This is sectional dictation. The country has never declined to stand by the miners for a fair consideration in return for fair production. Production now is not what 1913 says it should be; nevertheless, the country has not sanctioned any depression of wages to an unfair level. But it has given an emphatic "No" to the claims for extraordinary conditions; and, if necessary, it will do it again and again.

The miners' leaders, Mr. Hodges said at Brighton, knew that the strike could not go on indefinitely. This any sane man would know. Another thing the leaders were cognizant of was that once the dam cracked which held back the men from going to the pits, there would be a steady inflow; and the leaders were faced with this eventuality, or with having to take upon themselves the responsibility of not allowing the strike to continue. It is easy to see that the alternative is Hobson's choice. It is deplorable that the leaders did not earlier recognize their responsibility in respect of this particular aspect of the matter. The only interpretation we can put upon the remarks of Mr. Hodges in this connection is that the responsibility for the strike was not that of the leaders, but of the men, and that the leaders were now going to take the responsibility for putting an end to it. The fact is the leaders have been responsible for the strike all through; and the eleventh-hour ballot was merely a subterfuge for getting rid of responsibility when the industry has been well-nigh ruined, and the miners' organizations reduced absolutely to barrenness so far as funds go. When these matters are brought to mind, it is with some little impatience that we read Mr. Hodges' words: "We "shall be able to say that from the darkest hour we "emerged, chastened it may be, but united and honorable." The ballot did not disclose any wonderful unity; and was it an honorable thing, for a purely political motive, when good wages were offered for a quantity of work at a lower level than that of 1913, to continue to cause so much unemployment and distress through the land? The Secretary of the Miners' Federation, if he took a ballot of the whole country on the question of the "honorable" issue of his Executive from this strike, would find that the preponderating view would be against his own.

The ears of the labour delegates at Brighton were so successfully pleased by the (on this occasion) superficial eloquence of Mr. Hodges, that a resolution was passed full of sympathy with the miners, and of promise of financial support. Support by industrial action could not be entertained. The "honorable" work of the Miners' Federation has been so subversive to the industries of the country generally, that all the trade unions have felt the burden of intensified unemployment; and they are aware that a general strike, instead of making things better for the miners, would make them worse not only for them, but for the whole of the workers of the country. The financial support that is likely to be forthcoming will be of very slender order. The trade unions have no millions with which to play after the miners' leaders have been afflicted by such feverish squandermania; and so Mr. Hodges was right when he indicated the hopelessness of going on, and predicted the nearing of the end of this miserable business.

The conference at Brighton passed a resolution declining to have anything to do with the Communist party, who are the avowed enemies of the constitution and of the nation. We are glad to hear that. The logical step would now be for every trade union to turn out neck and crop the Communists that are to be found in the administrative seats of these organizations; for a pretty good attempt has been made lately to wreck industry and injure the nation. This has brought about a large amount of chaos, loss, and misery; but fortunately there has been failure. However, after the Brighton conference, matters moved with dramatic swiftness in regard to the strike. The Executive of the Miners' Federation saw that they could not hope for any adequate support from any quarter that would justify them in continuing to hold out; and replies received from other unions interested in wages questions verified the conclusion that they had obviously come to. All the boastings as to fighting the battle for labour generally, and not for preferential consideration for the miners, had not had sufficient persuasive effect; and there were no other unions prepared to help to add to the mischief that the extremist element of the Miners' Federation had inflicted upon the country through their obstinacy in adhering to their foolishly extravagant and indefensible demands, and declining to discuss the two things that matter most—wages and production. It was also seen that no financial assistance could be expected that would in the aggregate be of any avail.

The inexorable facts of the position had to be faced; and so the moderate part of the Executive once more came into power, and had to handle the position created by their

headstrong and blundering colleagues. There was only one avenue of escape from the mess, and that was by the Miners' Federation Executive asking the Government to arrange a meeting with the owners to discuss a satisfactory wages agreement. Nothing was said in the communication about a national pool, though it was an open secret that the miners were hoping to secure the previously rejected £10,000,000 subsidy to help to tide over the restoration period. What, in our opinion, the Executive regarded as equally important was the regaining of that sum to show that the struggle had not been altogether in vain. But, if secured, it will only help to show the more intelligent miners (who will measure the £10,000,000 against the £40,000,000 to £50,000,000 loss in miners' wages) how they have been misled and fooled by their more arrogant leaders. This strike has been a perfect disaster for the miners themselves; and generally it represents nothing but pure waste and destruction for individuals and the nation—a waste of time in millions of human lives, and a waste of substance which the country cannot afford. Those who have been responsible for this deserve to be pilloried by the whole of the workers' organizations in the country; but the trouble is that, among the representatives of labour, there appears to be no one with sufficient courage to take the lead in doing something that would have a beneficent and steadying effect in these days when diplomatic action is as necessary in the interests of the workers themselves as in those of the country at large. Nothing but work and production will pull the country through now. The statistics of coal production, this three months' strike, and the incidents connected with it ought to satisfy every other trade unionist in the country as to the part the miners (speaking collectively) have taken in obstructing the country in the work of rehabilitation.

Negotiations took place with the representatives of the Mining Association on Monday; and a provisional agreement was reached, subject to financial subvention from the State. At the time of going to press, there are rumours as to the agreed conditions; but we will leave the matter here until the full terms are officially available. There is assurance, however, that in them there is no reference to the national pool, or objection to the district regulation of wages. Whatever the exact terms, there is great satisfaction in knowing that there is not much time lying between the present and the re-opening of the pits.

Thermal Efficiency and a Busy Week.

THERE has been a great awakening in respect of the efficient and economical utilization of fuels in industries of all kinds. Protagonists in this matter have been Prof. W. A. Bone, Sir Dugald Clerk (with whom have been associated Profs. Smithells and Cobb); and there is the work that is proceeding at H.M. Fuel Research Station by a talented staff, under the direction of Sir George Beilby. What has been done in these quarters has given great impetus to individual investigation and other work in all industries. Fuel and heat in industry take precedence of power; power being a product of them both. But the Government, in its insouciant way where matters technical are concerned, in its war-time inquiries put the cart before the horse. They caused consideration to be given to one side of the power problem only, and left the general question of fuel and heat outside the ambit of reference, and went merrily along the electrical way, until at the present time they find themselves in a glorious muddle over their original plans, which are not going to work-out according to the predictions of the interested electrical prophets and advisers of the Departments. However, this is not the time for recrimination; it is the time for work in this matter of thermal efficiency in industry, and engineers and industrial chemists are wide awake to the fact. This week there are conferences at the Institution of Civil Engineers and the Institution of Mechanical Engineers; and the remarkable feature of them is that the questions of fuel economy and thermal efficiency bulk so largely in them. It has a good place in the conference at the Civils; it is the one topic at the Mechanicals. The engineers and industrial chemists are busily at work. Over this there is the liveliest satisfaction on the part of the protagonists, and of all who desire to see the economical use of fuel and the utmost profit derived from the utilizing of our coal. The Civils and the Mechanicals are this week engaged on a practical piece of missionary enterprise.

In most industries now where there are men who are qualified for the work, investigation into the fuel problem is proceeding, and those who follow up this interesting development find themselves in every quarter of technical activity doused in chemical formulæ, equations, physical constants, and other pertinent things. The makers of our heat developing and utilizing apparatus and appliances are also busy. They must be well in the trend of things; or they will inevitably be swept away. Manufacturers of steam-boilers are seeing how they can, by internal and external design or by auxiliary expedients, raise the evaporative duty of their plant, and increase the average efficiency from 50 to 60 p.ct. up to something that shall represent—shall we say?—70 to 80 p.ct. It is a fight between them now with the buyer's decision based on thermal efficiency. And the producers of steam-engines and turbines are aiding and abetting the boiler makers; for they are being pressed hard by the makers of internal combustion engines using gas and oil, and requiring no boiler plant or big chimney shafts. And even the chimney shafts are threatened with having a less monumental character by the utilization of gas under boilers (realizing a higher efficiency than with coal), as by the Spencer-Bonecourt system, or by the use of coke or fuel oil. There is keen competition now among the fuels; and, in determining which is the fittest for survival under any set of conditions, thermal efficiency will come very prominently into play. Flexibility, too, is a factor. The coal strike has shown that the ability to change from one fuel to another in industrial operations is anything but a negligible factor in industrial equipment. So in the matter of fuels—coal, coke, gas, and oil—while thermal efficiency will in future, owing to the need for, and pressure of, economy, be the most potent force, flexibility will be a consideration in both heat and power provision. With industries agog over the problem of the economical, and therefore efficient, utilization of fuels for the production of heat and power, we can see a diminishing necessity for the large super-power stations and transmission losses on which the Government so largely planked two or three years ago.

From the general to the particular in regard to this week's doings in relation to the question of thermal efficiency in industry. Sir George Beilby set the ball rolling last evening by dealing in the James Forrest Lecture with "Fuel Pro-"blems of the Future" [see p. 737]. This morning, Mr. E. G. Stewart, of the Fulham station of the Gas Light and Coke Company, is introducing a discussion on the "Utiliza-"tion of Waste Heat in Gas-Works." We have previously had a good insight to Mr. Stewart's capacity for dealing with this problem. On the same occasion, Dr. J. S. G. Thomas, of the chemical and physical staff of the South Metropolitan Gas Company, is dealing with "Desiderata in the Quali-"ties of Town's Gas." We have had some of the results of Dr. Thomas's research work in the "JOURNAL" on previous occasions. These two papers are published to-day; any discussions to which they may give rise will appear next week. With Dr. Charles Carpenter in the chair and the President of the Gas Institution (Mr. Thomas Goulden) one of the Vice-Chairmen, good discussions will be looked for. The James Forrest Lecture and the two papers mentioned do not by any means exhaust the papers which will have relation to fuel economy and thermal efficiency at the conference of the Institution of Civil Engineers; but they are the communications in which our readers will be primarily concerned. The Institution of Mechanical Engineers Conference to-morrow and on Friday will show the spaciousness of the area covered by thermal efficiency in industry. Every item in the programme touches on the subject, commencing with boilers, steam-engines, internal combustion engines, along to application. We shall be particularly interested in two of the papers—that on the "Chemistry "of Combustion," by Mr. E. V. Evans, F.I.C., chief of the chemical staff and chemical products manager of the South Metropolitan Gas Company, and that by Prof. W. A. Bone on "Low-Temperature Carbonization." There will also be attraction in Mr. Robert Nelson's paper on "Waste-"Heat Utilization."

In connection with the conferences, members of the Institution of Gas Engineers will have the pleasure of visiting the Fuel Research Station this afternoon; other engineers on Friday. Great technical interest will be found there. On Thursday afternoon, at 3 o'clock, there will be a visit (under the guidance of Prof. Bone), in connection with the Mechanical Engineers' Conference, to the Department of Chemical Technology at the Imperial College of Science. Also at the Institution of Mechanical Engineers, there will

be, from to-day to Friday, an exhibition of apparatus, models, and diagrams illustrative of the developments contributing to fuel economy and working efficiency. The subject is very much alive to-day. That is good. What it all means is too apparent to need specific mention.

The Bank Rate.

Last Thursday the Bank rate was reduced to 6 p.ct. from the 6½ p.ct. at which it has been since April 23, before which it was at 7 p.ct., at which it had stood for over a year. Industry cannot fail to benefit from the reduction, though there is at present no indication that money will be more plentiful in the immediate future. At a meeting of gas shareholders that was being held as the news came through on Thursday, there was applause when the Chairman made the announcement.

Shareholders and Loans.

Several gas companies have been issuing redeemable debenture stock at 7½ p.ct. They have been forced to offer a high rate of interest owing to the statutory limitations which caused the dividends and the market values of their ordinary stocks to come down with a crash during war time, and to continue down under the bad post-war conditions. The issues have been taken up with avidity. But 7½ p.ct. is a high rate of interest for loans which have to be repaid within a fixed period. In view of the fact that gas undertakings have debenture stocks which are receiving (say) only 4 or 4½ p.ct., Mr. H. E. Jones thinks these new issues should as far as possible be confined to the existing shareholders. He expressed his views on the subject at the meeting of the Bombay Gas Company, reported in this week's "JOURNAL." He does not like the idea of outsiders coming in and getting these high rates of interest, while those who have provided the capital that has borne the "heat and burden of the day" are receiving less return for their money. If, therefore, shareholders would provide the requisite temporary loans at the high rate of interest at which they are issued, they, at all events, would be getting in most instances something better on the average of their investments in a gas concern than they are doing to-day. There will be entire sympathy with the views of Mr. Jones on this matter; the trouble is that at the present time so many gas undertakings require such a large amount of money that the shareholders (whose gas incomes have been so substantially reduced) could not supply the lot. It would be an ideal condition of issue to get loans from existing share or stock holders; but it is not generally possible. Perhaps it will be in the case of the Bombay shareholders.

The Reason for the Corporation Tax.

There was a little discussion in the House of Commons the other night on the Corporation Tax; and the Chancellor of the Exchequer (Sir Robert Horne) defended the imposition of the tax upon limited liability companies. His view is that such companies enjoy special privileges under the law, in that their existence is perpetual, and not subject to charges which at the death of individuals fall upon their estates. Those who invest in such companies also know that, whatever happens, their losses are limited. The theory of the tax is that a payment should be made for the privileges. Statutory gas undertakings are free from the tax for a period. In their case the privileges they enjoy are fairly slender compared with the advantages reaped by the public from the service rendered by the capital invested. Moreover, their dividends are regulated; other trading companies not working under Special Acts are unlimited in the payments they may make if profits are earned. There are several differences between the one class of company and the other.

Summer Time.

The long-promised Bill has been presented to the House and read the first time which is to provide permanently for the time in the British Isles being in advance of Greenwich mean time during a certain period of the year.

Imported Coal.

It will be impossible, immediately the British mines get into working stride again, for the Government to cancel orders for coal from abroad for which contracts have been already entered into. Any Government imported coal (if any) that remains unsold after the resumption of work in the mines will be disposed of to the best advantage in the circumstances. Apart from Government contracts, so long as foreign coal can compete with coal prices in this country, there will be importations, especially if of good class—low in ash and sulphur.

Iron and Steel Industry Coal Costs.

The iron and steel industry in this country is in a precarious position. The output of the industry to-day is practically *nil*. The number of furnaces in blast fell from 303 in September, 1920, to 109 at the end of March, and to 11 at the end of April. A similar condition exists so far as steel-producing and ancillary plants are concerned. Continental production is now selling at a low price, owing to the lower level of wages in Germany, the fact that Lorraine and Belgian manufacturers have not been so heavily taxed, the special railway facilities, and the foreign exchange situation. With costs what they were before the coal strike, the iron and steel industry cannot hope to restart. In a memorandum on the subject, issued by the National Federation of Iron and Steel Manufacturers and the Iron and Steel Trades Confederation, it is stated that the value in 1920 of the output of the heavy iron and steel trade (exclusive of wrought-iron, galvanized sheets, and tinplates) has been roughly estimated at £193,000,000. Certain main items are: (*a*) Direct wages of the iron and steel workers in these branches are estimated at £51,500,000. (*b*) The cost of the 28 million tons of coal consumed annually by these sections of the trade is estimated at £46,500,000 (of which at least £34,000,000 represents coal-miners' wages); a further £12,500,000 is the cost of converting 15 million tons of the coal into coke, making the total fuel bill £59,000,000. Home-produced ore costs £15,500,000. That is, put briefly, the serious position. The greater part of the £51,500,000 paid as wages to iron and steel workers is governed by sliding-scales; so that the wages are already falling with the drop in iron and steel prices. The total cost of material was valued last year at considerably over £70,000,000, of which nearly £50,000,000 went in direct wages. Therefore, reduction of costs largely depends on what happens in the coal industry, more especially seeing that the wages of British ore miners and most coke-oven workers follow miners' wages. It is the considered opinion of the employers that the industry will not be able to restart unless fuel, as well as other items, are reduced to a level at least not higher than from 75 to 100 p.ct. above pre-war figures.

Coke Exports and Values.

Last month only 17,261 tons of gas coke were exported, and 123 tons of other sorts. These figures compare with 34,172 tons of gas coke and 43,626 tons of other sorts in May, 1920. The values last month were respectively £30,812 and £437, compared with £200,397 and £241,376 in May last year. These figures are startling enough; those for the five months are even more so. From Jan. 1 to the end of May, 217,603 tons of gas coke were exported, and 64,891 tons of metallurgical coke. The values were £562,383 and £263,085 respectively. Compare these figures with those for the five months ending May, 1920. The gas coke exported amounted to 297,140 tons; the value was £1,451,921. Coke of "other sorts" totalled 566,816 tons; and the value was £2,885,474.

Recent Wills.—Lord Moulton, who died in the early part of March last, has left estate of the value of £162,506. The will has also been proved of Mr. Robert Porter, of Elland, who left £22,445 gross.

Early Natural Gas.—Mr. R. B. Verdery told the members of the Southern Gas Association of America that natural gas was known to exist in Persia, China, and British India, for many centuries, though it was not put to commercial use. It appeared as leakage from gas-bearing strata through crevices in the ground; and when lighted by the natives, it was worshipped as a "fire god." Mr. T. Shirley, in 1669, attributed a burning well at Wigan, in England, to the presence of coal underneath it. In America, as early as 1775, George Washington dedicated to his country, as a national park, a tract of land in West Virginia, containing a burning spring. This, too, was leakage from a crevice in the ground. The first discovery of natural gas by drilling occurred through the sinking of shallow wells for salt in Ohio, and West Virginia; but the first actual use of such gas for light was at Fredonia (N.J.) in 1826. Titusville (Pa.) was in 1872 piped for natural gas for domestic purposes, being supplied through a 2-in. main from a well about 5 miles north of the town.

ELECTRICITY SUPPLY MEMORANDA.

IN connection with imported coal, this country is being made the dumping-ground for a great deal of rubbish. There must be a protest against this. In view of the prices that are being paid, we are entitled to material that has a respectable calorific value, and is not too heavily laden with ash and charged with sulphur. There is no question about it that near Continental countries are retaining the best grades of coal for themselves; and it may be fairly assumed that the exporters of these countries are buying-up at a relatively low price the inferior stuff, and selling it for shipment here at high prices, when, in view of the fuel shortage in this country, the highest calorific value is wanted out of every pound, and for gas supply purposes the utmost yield of gas. The electricity supply people are feeling very acutely the effects of poor quality coal. With much of the imported coal, boilers are not yielding their normal duty; and the result has been that deficiency of steam and pressure has resulted in an uncomfortable number of breakdowns of electric train, tram, and general supply services. This was the explanation of the breakdown last Saturday week of the London Underground Railway service, and to a recent failure of the general supply at Acton. These are merely examples of many like troubles. We may be told that the other countries are only following a war example, and that it is not for us to complain now that it has come to our turn to be the recipients. Then it was war time, and there was a shortage of labour in the mines here as elsewhere. We are not at war now; and this coal is coming to us with plenty of labour available abroad as here.

Dumping Ground for Inferior Coal.

While these perverse and inconvenient electric stoppages are occurring, in some places increased train, tram, and general supply services are announced, owing to oil-fuel being used under the boilers. At the Lot's Road generating station, some of the boilers are now fitted with oil; and these were not chargeable with the mishap referred to in the preceding paragraph. Far from that, oil-fuel has been working wonders in enabling those responsible for the transport of the human species to restore practically normal running. The London United, the Metropolitan Electric, and the South London Electric Tramways announce that full services are to be reinstated. It is seen, too, that owing to increasing difficulties, four boilers at the London County Council Greenwich power station are being equipped with oil-burning appliances. In this case, the total cost, including the provision of the necessary pipe-line, is estimated at £4200. The cost of converting one boiler at Aberdeen is reported to have been £700. At the City of London station at Bankside, boilers have been changed-over to oil-burning; and no coal need be used there before September. We were recently talking about making electricity stations more flexible by enabling them to run on coal, coke, or oil, according to the circumstances of the fuel market. Mr. Frank Bailey, the Engineer, intends to be able to change-over just as and when he likes. At Smethwick, we see, there has been no necessity to impose any restrictions upon the supply of electricity, as the Power Company have been using oil-fuel as an adjunct to coal for the past twelve months. It would not do, however, exclusively to confine oneself to oil-firing. People who have used oil for a long time know something as to price vacillations; and students of the oil position are aware, too, that America appreciates that its natural storage of petroleum is not illimitable. The warning against placing one's "eggs all in one basket" applies to oil as well as to coal, with inconstant labour such an important factor in respect of supplies.

The Oleaginous Alternative.

The old polemical subject as to whether it is better to burn gas under steam-boilers or to use it in a gas-engine for the direct generation of electricity is being carried on now in connection with oil. But the use of oil as a fuel is being adopted to "fill the bill" in an emergency created by the coal strike, and with the plant at the generating station as it exists. It is a question of making the best use of the plant in the quickest available time, as it is impossible to instal expensive new engines in a few days. But the advocates respectively of oil-driven engines and oil-burning under boilers for the generation of steam and the use of turbines are having a little wrangle over the subject, looking upon the considerable changes that have been made in boiler-firing as having the appearance of durability. Possibly the oil-engine champions are afraid the present conversions are going to limit their field. A writer in the "Electrical Review" says it is ridiculous from a scientific point of view to burn under a boiler any fuel which will work in a gas-producer, of anything like normal design, or, still more, which will burn in a Diesel engine cylinder. Actually about three times as much oil is used under boilers as under the cylinder cover of a Diesel engine—both being in good order, with an average load factor. Supposing turbo-alternators are absolutely reliable—that is, the cost and trouble of running them are zero. Take boilers capable of supplying 2000 KW. each, and, for the sake of comparison, Diesel engines capable also of supplying 2000 KW. each—will the gain due to the decreased consumption of oil be worth the trouble and expense of Diesel engines? The writer replies in the affirmative, because he has used both. Everyone should figure this out in his own case, and then subtract any trouble he may have had with a turbine. To put a Diesel engine set on load, he says will only take (say) twenty seconds; and in the event of a strike, given plant in good condition, a Diesel engine station can be run more easily than a steam-raising one. But in order to secure elasticity, the best solution of the problem is to be in a position to change-over readily from one method to another, and not to be tethered to any one system.

Oil-Burning and Oil-Driving.

We are carried further in this matter of generating possibilities by Major T. G. Tulloch, R.A., late Chief Superintendent of Research at Woolwich, in "Engineering Notes" in the "Daily Telegraph." He deals with the question as to whether large generating stations for traction purposes are really required. In his opinion, they are not. His view is that it is only necessary to subdivide trains into units which can act together, if necessary, to form one train, with each unit of (say) two or three carriages carrying its own generating plant. This, he suggests, should consist of a portable gas-producer, a gas-engine, and a dynamo, with all the wheels (or several of them) fitted with a motor. Of course, the same system could be applied to tramways. By this means, the central power stations, and all the electrical connections and conversion sub-stations, with their high capital cost and maintenance charges, to say nothing of the danger of live rails, would be swept away. The only addition to existing plant would be the provision of gas-producers, gas-engines, and dynamos, each of comparatively small size. The present motors could be utilized. Furthermore, all existing mains and branch lines awaiting electrification could thus be electrified very rapidly, and at comparatively small cost. Of course, another advantage which would be gained by decentralization combined with the use of gas-engines—or better still, gas-turbines—is not only the greater economies effected in fuel consumption by substituting gas-engines for steam-boilers, but the smaller "stand-by" losses, as, broadly speaking, these losses with steam power are about ten times greater than with gas power. These "stand-by" losses are reflected in a central power electric station by the necessity of always having a minimum of current under generation, no matter what the demand may be, and by a considerable consumption of boiler fuel while the engine is not working. Stand-by losses with steam-boilers, taken on a broad average, run to about 20 p.ct. of the total fuel bill; with gas power, to only about 2 p.ct.

Decentralization by Gas Producers and Engines.

If the Grimsby Corporation Bill gets through Parliament successfully, it will contain a clause which will give statutory recognition to a bi-part tariff for electricity supply—a subject about which there has of late been much talk. The Bill has already passed a Committee of the Commons; and the clause in question enacts that:

> The Corporation may in all or any cases where they supply electrical energy, charge for and in respect of such supply by any method for the time being selected by the Corporation, and approved by the Electricity Commissioners. Any such method may be other than by the actual amount of electrical energy supplied, or the electrical quantity contained in such supply, and may authorize *a periodical charge in respect of the maximum power required by the consumer, in addition to a charge for the electrical energy supplied to him.*

We do not know that much courage was required to put the clause into the Bill; but anyway "Electrical Industries" congratulates the Corporation upon their courage in doing this wonderful thing. Our contemporary seems to take it for granted that the Electricity Commissioners are going to deal with the question of two-part tariffs in general legislation, although there is a little lurking fear that even electrical tariff reform will arouse some opposition in political circles. The further hope is expressed by our contemporary that the Grimsby example will be copied by other local authorities, and that the Electricity Commissioners will express their pious opinion that a two-part tariff ought to be made compulsory. Why not optional?

A Bi-Part Tariff Clause.

A correspondent in "Electrical Industries" holds-out an appalling prospect for the electricity supply industry. In his opinion, if the Electricity Supply (No. 2) Bill, which is now accumulating dust on the parliamentary shelves, becomes an Act of Parliament, it will give rise to circumstances which will force the Government to bring in a further measure. This would consist of the remainder of the clauses jettisoned from the original Bill of 1919. These clauses, being of a compulsory character and heavy in financial obligations, caused much dissatisfaction in the House of Lords; and so the Government excised them in order to get vital parts of the original Bill on to the Statute Book. Since then they have not had the courage to enact them. They once intended doing so; but second thoughts changed their view. This is about the only wise thing the Government ever did in connection with this matter of the re-organization of electrical generation, which nobody can say means economy or otherwise. But all through this electrical business,

If Electricity Bill (No. 2) Passes.

the situation has been subject to change. Another change has lately come over the scene; and it may have a considerable influence in altering the course of the present policy of the Government. It has been seen that there is a disposition on the part of local bodies to keep outside the Joint Authorities, and to have nothing whatever to do with them. Then there has been the withdrawal of the Lower Severn scheme. Thus there is not to-day the co-operation that the Government anticipated there would be at the time they introduced the revised version of the Electricity Supply (No. 2) Bill. Even if this measure passes, it will only apply to those authorities who are willing to co-operate, which will mean that there will be only piecemeal organization if matters go no further than they would be carried by the No. 2 Bill—if it ever reaches the status of an Act of Parliament. Therefore the correspondent of "Electrical Industries" is of opinion that if No. 2 Bill lives to be an Act, it will be necessary to bring in a third Bill to impose compulsory adhesion to the joint schemes, together with the compulsory transfer of generating plant and transmission cables. This is a condition of things that most electricity supply authorities would totally abhor. When regarded in this light, it is probable that some of the local bodies who are now supporting the No. 2 Bill will feel inclined, with the shadow of a third Bill before them, to turn-over to the side of those opposing it.

"Grit" from an Electricity Station.

The Hereford Electricity Committee have a penchant for spending money rather heavily and frequently. The people of the city have been for some time past rather suspicious of this; and now there is very close scrutiny of the proposals that emanate from the Committee. But it seems they have been threatened with an injunction to restrain their generating station from being a nuisance to its neighbours, through distributing grit *via* the atmosphere—not constantly but intermittently. We suppose there is mechanical coal-handling at the station, and that it is when the coal is of a dusty variety that the trouble arises. The Committee therefore asked the Council to sanction the spending of £6000—about half to be expended on dust-extracting plant, and the balance on covering-in the coal-storage yard. The Council seem a bit impatient with the Committee; and they wonder why they cannot store and deal with coal the same as other large users—without being a nuisance to their neighbours. There have been cases of nuisance by noise, vibration, and smoke from electricity stations; but this is the first time that we have ever heard of "grit" from one being a nuisance. However, the Committee are to be given another chance (before being authorized to spend the £6000) to consider whether they cannot carry-on their operations without causing trouble. The £6000 would not be financially productive.

PERSONAL.

The two months' rest from business which Mr. C. VALON BENNETT, the Engineer, General Manager, and Secretary of the Rochester, Chatham, and Gillingham Gas Company, was ordered by his doctor to take, has, we are glad to learn, proved a complete success. Mr. Bennett's voyage to South Africa and home again was a pleasant one; and he now feels entirely recovered, and fit once more to take up the reins of office.

Action has been taken during the past year by his many friends and co-workers in various spheres, with a view to providing a fitting tribute to the work done, and the success achieved, for the National Physical Laboratory by its first Director, Sir RICHARD GLAZEBROOK. It was decided that this should take the form of a bas-relief portrait in bronze, to be executed by M. J. Cluysenaar, of Brussels, and to be erected in the main Administration Building at the Laboratory.

Germany and the Coal-Tar Industry.

Relating to the American Chemical Society some of the incidents connected with his early training, Dr. Charles F. Chandler referred to the advantages offered as far back as the middle of last century by the laboratories of the German Universities. It was in 1854 that he and a companion went to Göttingen to study under the eminent chemist Wöhler; and even at that early time, he found that Germany fully realized the importance of professional chemists. From the facts which he pointed out, it could, he said, be understood how it happened that, though the coal-tar industry started in 1856, it was promptly monopolized by Germany, where there were a host of chemists, old and young, to devote themselves to its development. The cost of living was low, salaries were moderate, and there were many well-equipped laboratories. Very soon the German chemists began to invent new dyes and synthetic medicines which they distributed to other countries; but, of course, some dyes and medicines originated elsewhere. The Germans also took out local patents in other countries, to prevent the manufacture there of their products. After the foreign patents expired, it was still very difficult, or impossible, to make these products in competition with the German inventors. The language of the German patents was carefully selected for the protection of the inventor, and not to instruct other chemists how to practise them. So the manufacture of dyes and synthetic medicines did not really flourish outside Germany.

SOCIETY OF BRITISH GAS INDUSTRIES.

Report of the Council for 1920-21.

WE have received from the Secretary of the Society of British Gas Industries (Mr. Arthur L. Griffith) a copy of the Council's report for the year 1920-21, that was to have been presented at the annual meeting which was fixed for the 15th inst., but had to be postponed. It is as follows.

The Council have pleasure in presenting to the members their fifteenth annual report on the work of the Society for the past year.

It is with regret that they have to refer to the loss which the Society and the whole of the gas industry has sustained by the death of the Rt. Hon. Lord Moulton—one of our highly esteemed Past Presidents.

We also have to record with regret the death of the following members: Alexander Mackay, the Chairman of Alder & Mackay, Ltd.; P. N. Cunningham, the General Manager of Stewarts and Lloyds; Thomas G. Marsh, of Manchester, one of the founders of the Society; William Armitage Drake, the Chairman of Drakes, Ltd.; James Dunnachie, sen., Managing Director and Chairman of the Glenboig Union Fireclay Company, Ltd.; and James Keith, Managing Director of the Keith and Blackman Company, Ltd.

The Society wishes to offer its congratulations to the following gentlemen: Sir Arthur Duckham, K.C.B., who has had the honour of the Cross of Officer of the Legion of Honour conferred upon him by the President of the French Republic for war services; Sir Alfred Keogh, G.C.B., G.C.V.O., the degree of Doctor of Science conferred upon him by the University of Oxford; Sir George H. Holcroft, Bart., J.P., on the baronetcy conferred upon him by His Majesty the King; Sir Robert Hadfield, Bart., the John Fritz Gold Medal bestowed on him for his invention of manganese steel; Mr. Fred. J. West, C.B.E., elected an Alderman of the City of Manchester; Mr. Thomas Duxbury, elected Mayor of Darwen; Mr. Albert Cliff, re-elected Mayor of Stamford; Mr. George Clark, J.P., elected an Alderman of Chesterfield; Mr. R. J. Milbourne, J.P., appointed a Justice of the Peace for the County of Shropshire.

SHEFFIELD MEETING.

The Council have pleasure in recording the unqualified success of the annual meeting at the Sheffield University in June of last year. The visits to Messrs. Walker & Hall and Messrs. Hadfield's works on the second day were of intense interest to the members; and what was seen there will be a lasting memory. We are indebted to the Directors of Messrs. Hadfields, Ltd., and the University authorities for the generous hospitality extended to us.

PAPERS FOR THE INSTITUTION OF GAS ENGINEERS.

The Society contributed a paper on "Carbonization;" with drawings, at the annual meeting of the Institution of Gas Engineers in June last year. It was read by Mr. Samuel Cutler, jun., to whom your Council feel the members of the Society are much indebted for the work he did in connection with the compilation. The paper has been referred to by several engineers as a veritable text-book on the subject, and as a unique record of current constructional practice in carbonization plant.

The Society was again invited to contribute a paper at this year's meeting of the Institution, the title of which will be "Tar Distillation and Sulphate of Ammonia Plant." The paper is on lines similar to last year's. The members of Section 12—Chemical and Residual Plant—were invited to contribute.

Mr. F. J. West and Mr. Samuel Cutler, jun., have acted as a Committee to deal with the preparation of the paper; and the former will read it at the Institution meeting.

SLIDING-SCALE CLAUSE IN CONTRACTS.

A conference took place in December last between representatives of the National Gas Council and the Society. The contractors promised to give careful consideration to the proposal made by the Council that the sliding-scale clause in contracts, under which adjustments are made for increases or decreases in prices of materials and labour should be abolished, and that in lieu thereof firm prices should be given in all future tenders. They have now decided that it is not expedient to issue a general recommendation on this matter, and have recommended that it should be left for negotiation between the contractor and his client as to whether tenders should be based on the sliding-scale clause or a firm basis for (say) the next six months, and that the position be then again reviewed.

ADDITIONAL COSTS IN CONTRACTS.

A conference took place last December between the representatives of the National Gas Council and the Society. The former put forward a suggestion that contractors should endeavour to provide a list setting forth the standard advances which have taken place in the prices of materials and labour under the sliding-scale clause in contracts. The matter has had the very careful consideration of the contractors. On investigation, it was found to be practically impossible to compile such a list, owing to the appreciable differences in the advances which have taken place in various parts of the country. The Council have been informed that the present method of procedure of settlement, by

mutual discussion and consideration of accounts, is the only satisfactory method of dealing with the matter.

PAYMENT CLAUSE IN THE STANDARD CONDITIONS OF CONTRACT.

The contractors have been in consultation with the Institution of Gas Engineers with a view to the payment clause in contracts being amended, owing to the considerable hardships and difficulties in carrying out contracts with materials and labour at their present high prices, and with other surrounding disadvantages; and your Council are pleased to report that the matter has now been settled on terms which have been communicated to the sections concerned.

REVISION OF GENERAL RAILWAY CLASSIFICATION OF GOODS.

This important matter was discussed at a meeting recently held in Manchester, when the members emphasized the great increases which will take place on contractors' materials if the revised scale is put into operation. A Committee was appointed to draw-up schedules of objections and counter-proposals to the provisional proposals of the railway companies. These schedules have since been forwarded to the Federation of British Industries; and the recommendations have received the careful attention of the Traders' Co-Ordinating Committee, and have been forwarded to the Railway Rates Advisory Committee.

LIFE OF GAS-METERS INVESTIGATION.

The Joint Committee of the Institution of Gas Engineers and the Society on the Life of Gas-Meters are continuing their investigations into the chemical factors affecting the life of meters, with the assistance of Mr. J. G. Taplay; and a further interesting report from him may be anticipated at the annual meeting of the Institution. Increased interest is being taken in this very important matter by gas engineers throughout the country.

The new standard list of sizes of dry meters has been approved, and will come into force by the 1st of January, 1922. It was felt that sufficient time must be allowed for the change, though probably most makers will be working to the new list before the date named.

A very important matter has been engaging the attention of the Committee—viz., the revision of the statutory rules for the testing of meters with a view of getting the provisions of the Sales of Gas Act of 1859 brought into line with modern conditions of gas supply. Conferences have been held with the statutory inspectors and the local testing authorities, and recommendations made to the Board of Trade. In view of the passing of the Gas Regulation Act, a deputation waited on the Board, who gave the matter their careful consideration; and the recommendations have now been adopted. The regulations were issued, and came into force on the 1st of January, 1921, superseding the present Sales of Gas Act.

BRITISH REFRACTORIES RESEARCH ASSOCIATION.

A Sub-Committee of Gas Research has been formed. The Joint Research Committee of the Institution of Gas Engineers and the Society have appointed Messrs. A. E. Broadberry, Thomas Hardie, J. P. Leather, and W. E. Price to represent the Institution; and Messrs. T. Allen, M. Barrett, Albert Cliff, and G. H. Pearson Perry to represent the Society on this Sub-Committee.

Our President has on several occasions urged the importance of closer working between the retort-setters and the manufacturers of fire-clay goods; and it has been suggested that Sections I. and X. should be joined-up. The two sections have, however, decided to hold joint meetings; and it is felt that much good will come from discussions of the needs of the one section and the difficulties of the other.

The Joint Committee of the Institution of Gas Engineers and the Society are, with excellent results, continuing their work on refractory materials research.

A further contribution by the members of the Fireclay Section was made, which, in conjunction with an equal amount subscribed by the Institution of Gas Engineers, has enabled the Government grant to be obtained.

GAS LIGHTING.

The Council have recently entered into an arrangement with the Illuminating Engineering Society in respect of the formation of a Joint Committee to keep in touch with all developments in gas lighting; and we trust this will be of service to the members of the Lighting Section. Our members on the Committee have drawn-up an interesting report on progress in gas-lamps and lighting appliances.

CHEMICAL ENGINEERING.

The Society was represented at the conference on chemical engineering arranged by the British Engineering Standards Association. The recommendations have since been brought before the Main Committee of the Association, who have decided to form a Sectional Committee on Chemical Engineering, of which our President has been appointed Chairman; and we shall also be represented upon it by one of our members.

QUARTERLY BULLETIN.

The Council have started the issue of a "Quarterly Bulletin" of the work of the Society and matters of interest to members. Several members suggested that something of the kind was very desirable, so as to keep them in touch with what is going on. It will be of great assistance if the members will from time to time communicate matters of interest to the Secretary, so that they can be recorded and help to make the "Bulletin" of real value.

GAS ENGINEERING DIRECTORY.

The Council have decided to issue a "Gas Engineering Directory," as they consider that such a publication is required—there being nothing of this character in the United Kingdom dealing with gas plant and appliances—and that a properly supported work of this kind must prove very valuable for reference by gas engineers, works' managers, and all who buy or specify equipment and materials throughout all branches of the gas industry at home and abroad.

A Committee was appointed, and has drawn up the lines on which the directory should be issued, of which our President has acted as Chairman, and we are much indebted to him for his help and advice.

It is hoped the proposal will receive the cordial support of the members, to whom all particulars have been sent.

CITY AND GUILDS OF LONDON INSTITUTE.

The Society's prizes in connection with the City and Guilds of London Institute examinations in gas engineering, gas supply, and gas-fitting have been awarded and duly announced in the Technical Press. These prizes act as an additional incentive to candidates not merely to enter for the examinations, but in preparation for them to attend recognized courses of instruction in the technical principles of their trade.

BRITISH COMMERCIAL GAS ASSOCIATION.

The Council have made a very determined effort to get the Society's subscription to the British Commercial Gas Association considerably increased this year. It is recognized that the benefits arising from the work done by the Association—not only in connection with their publicity advertising, but also in regard to the great efforts they have made to impress the claims for gas upon the Ministry of Health and housing authorities throughout the country, in addition to their activities in many other spheres—must reflect very largely upon the manufacturers connected with the Society; the increased popularity of gas obviously reacting favourably in this direction.

GENERAL.

The foregoing report refers to the principal matters that have come under the survey of the Council. Many other important subjects have been dealt with, to which it is impossible to refer in a brief report of this nature.

The Society wishes to accord its best thanks to Sir Arthur Duckham, K.C.B., for his valuable services as President during the past two years. On his retirement, he has been pleased to accept the office of a Vice-President; and we hope we may long have the benefit of his counsel and advice. As a special mark of appreciation of his services as President, the Council propose at the annual meeting to recommend him for honorary membership of the Society.

The Society desires to place on record its best thanks to the President for his able address, entitled "Labour's Position in Industry," and to Mr. Cyril G. Davis, M.I.Mech.E., for his paper entitled "The Changed Conditions of Industry," both of which led to very interesting discussions.

The Council have much pleasure in announcing that Mr. J. H. Balfour Browne, K.C., has accepted the Presidency of the Society for the coming year. He has always taken the greatest interest in our work; and we shall heartily welcome him again to the presidential chair.

The Council much regret that Mr. F. G. Cockey, the Vice-Chairman, for reasons of health and pressure of business, is unable to see his way to be nominated as Chairman of the Council for the coming year, and wishes to place on record their appreciation of his services to the Society.

On behalf of the Council,

(Signed) CYRIL G. DAVIS, Chairman.

May, 1921.

Problems of the Gas Engineer.

Addressing the Empire Gas and Electric Association, Mr. R. S. M'Bride, of Washington (D.C.), remarked that there is by no means unanimous agreement upon any solution of the problem which confronts the gas engineer—namely, how coal products can be most economically obtained. Indeed, it is doubtful whether any single process is at all suited to the wide variety of conditions which must be met. Complete gasification of coal will doubtless do much to advance the art of coal treatment in localities where the disposal of coke is not easily accomplished. Low-temperature carbonization affords equally promising possibilities for the future, through the supply of larger percentages of the fuel in the form of light oil, and particularly valuable tar. In all cases, however, it is improved technology and complete recovery of the most valuable products that must be striven for. Some other proposals have been made which are commercial rather than technical in their significance. These include co-operative systems of marketing and the centralization of gas manufacture, or the establishment of super gas-stations. But with all the improved technology, and with even the best of management, the gas industry still finds that efficiency may in part defeat its own ends. If all the gas and coking plants of America were managed as well as the best, a new phase of the problem would likely arise—namely, an inadequate market for the products. Both gas engineers and managers, therefore, are, or should be, much interested in the chemical programme of the nation.

THE "WOODALL" MEMORIAL EXPERIMENTAL GAS PLANT.

THE gas plant specially designed for experimental purposes which Mr. Henry Woodall is erecting as an adjunct to the Department of Coal Gas and Fuel Industries of the University of Leeds, as a memorial to the late Sir Corbet Woodall, is now in process of construction. The necessary work is being taken in hand by several firms specially qualified to deal with the type of construction required. Messrs. Woodall-Duckham are making themselves responsible for the special vertical retort installation, which has been designed to allow of experimental work at high temperatures and under conditions which ought to be investigated, but are not at present normal practice, and could not be attained on a full-sized standard plant. Messrs. Gibbons are undertaking the horizontal retort work, and Messrs. Clayton the gasholders. Mr. A. G. Glasgow has recently expressed his desire to associate himself with this particular memorial to the memory of Sir Corbet Woodall, and has made a donation of five hundred guineas to be used for the purpose.

ENGINEERING CONFERENCE OF THE INSTITUTION OF CIVIL ENGINEERS.

The Engineering Conference under the auspices of the Institution of Civil Engineers, which opened last night with the James Forrest Lecture on "Fuel Problems of the Future," by Sir George T. Beilby, F.R.S. [see p. 737], is being resumed to-day and the two following days, when the seven separate sections will discuss a large variety of subjects, and a number of visits will be paid to works and other places of engineering interest—including the Fuel Research Station at East Greenwich. The President of the conference is Mr. John A. Brodie, M.Eng.

Section VI. will devote itself to Water-Works, Sewerage, and Gas-Works. The Chairman is Dr. Charles Carpenter, C.B.E.; and the Vice-Chairmen Messrs. Thomas Goulden, E. P. Hill, G. W. Humphreys, C.B.E., and G. Midgley Taylor. One of the three Hon. Secretaries is Mr. Frank H. Jones. The "gas" portion of the section's programme will be taken this [Wednesday] morning at 11.30; the subjects for discussion being introduced by the following notes.

THE UTILIZATION OF WASTE HEAT IN GAS-WORKS.

By EDWARD GEORGE STEWART.

The low cost of steam-raising, due to the availability of cheap fuel and the high efficiency of conversion of the potential energy in coal, seem the only reasons which have prevented the earlier application of waste heat recovery on a wide scale in the gas industry. With greater necessity for the conservation of coal, and further economy in gas production, the prospects of securing in a simple manner financial benefits and technical efficiency by this means assume considerable importance.

The available sources of waste heat are as follows:

1.—The sensible heat of the waste gases of retort furnaces.

2.—The sensible heat of the blast products of water-gas generators and the potential energy of producer gas contained.

3.—The sensible heat of the products leaving the plants.

Any energy recovered may be readily applied to the following purposes:

(*a*) *Power to the Works.*—This is usually derived from steam generated from coke or coke breeze (fuels which are now receiving appreciation from outside consumers) and town gas-engines. Convenience in transmission has already resulted in many works in a proportion of the power from these prime movers being transmitted by electricity.

(*b*) *Water Gas.*—In the supply of steam to effect the reaction in water-gas manufacture.

CARBONIZATION.

A ton of coal, having a calorific value of 300 therms, will furnish some 14 cwt. of fuel products for actual sale. In the form of gas, 68 therms; coke, 148 therms; and oil, 17 therms—*i.e.*, a return of nearly 78 p.ct. The remaining 22 p.ct. is lost or used in the process as follows:

1.—Process losses amounting to 29 therms.

2.—6·8 therms pass away in the sensible heat of the crude gas and tar vapours leaving the retorts. Much of this is dissipated by radiation and absorbed by the liquefying of constituents. By the use of water-tube gas-condensers, an amount of heat equal to about one therm can be recovered as hot water at 130° Fahr., which can be utilized as boiler feed—preferably after further heating by exhaust steam.

3.—Ten therms are wasted in the sensible heat of the flue gases leaving the retort-setting recuperators at 1000° to 1250° Fahr., and more in certain vertical retort plants without recuperation. From this source profitable heat recovery is easy.

Combustion in retort-settings is normally complete, a typical analysis being:

	Per Cent.
CO_2	19
CO	*nil*
O_2	0·4
N_2	80·6

Such a waste gas would carry away, per pound of fuel burnt, 3580 B.Th.U. above atmospheric temperature, or 2510 B.Th.U. above 400° Fahr., with an initial temperature of 1200° Fahr. Passed through a boiler of 70 p.ct. efficiency, the quantity of steam generated would equal 1·56 lbs., at 100 lbs. per sq. in., per pound of fuel burnt; at 1000° Fahr. the quantity would still be 1·1 lbs., or 490 and 350 lbs. of steam respectively per ton of coal—the exit gases in each case being at 400° Fahr.

A reduction of flue gas temperature by 800° at the base of the chimney reduces the draught from 17·5-10ths to 14-10ths, which is a factor to be remembered, as the boiler may cause further loss by back-pressure. Reduction below 400° Fahr. necessitates the installation of induced draught plant and involves difficulties with corrosion, arising from the sulphur content of the gases. Such boilers are being successfully applied on inclined retorts at Brentford—2900 lbs. of steam per hour being produced per 3 tons of coal carbonized.

On Woodall-Duckham verticals at Birmingham, yields of 500 lbs. of steam per ton of coal are being obtained from an installation handling over 400 tons of coal daily (800 to 1000 gallons per hour).

With Glover-West retorts at Macclesfield, 700 lbs. of steam per ton are being obtained.

In considering results of this nature, it should be remembered that the efficiency of steam production is relative to the inefficiency of regeneration in the carbonizing plant.

4.—A net loss of 9 therms is incurred in the sensible heat of the coke discharged from the retorts at a temperature of 1800° Fahr., after a portion of the hot coke has been returned to the producers. In continuous verticals the coke is discharged from the retort at a low temperature, giving a loss of about 2·3 therms only; but the extracted heat is usually employed for heating the air to the retort producers, in place of the waste gases, which gives a corresponding increased recoverable loss.

Recently a Swiss firm has introduced a process in which successive charges of hot coke are passed through a large container. After each filling this is sealed, and the enclosed air becomes converted to carbon dioxide and nitrogen. These inert gases are circulated through the contained coke and an adjacent waste-heat boiler, until the temperature of the coke is reduced to 400° Fahr. Results from the installation of this process at Zurich and elsewhere show that 600 to 800 lbs. of 140 lbs. pressure steam can be generated per ton of coke, equal to 300 to 400 lbs. per ton of coal (3·5 to 4·7 therms recovered).

5.—The heat usually required on works for power generation is about 12 therms; and as the chief business of a gas undertaking is to produce fuel, it represents a loss of sale products. The equivalent quantity of steam represented is some 600 lbs. per ton of coal, which is generally employed uneconomically in small scattered units, and could be reduced considerably by the adoption of electric transmission. All power could then be generated by efficient steam-engines, with possibly a small proportion of gas-engine generators. More than sufficient steam could be derived from waste-heat sources, thus:

(*a*) Feed water from gas-condensers further heated by exhaust steam.

(*b*) 340 to 450 lbs. per ton from boilers at retort-house chimney base.

(*c*) 300 to 400 lbs. per ton from hot coke.

Assuming a value for steam of only £1 per 1000 gallons evaporated, the saving indicated by the use of waste-heat boilers applied to the works' power demand is equal to 14·4d. per ton of coal, or 0·2d. per therm.

WATER-GAS MANUFACTURE.

Assuming a quantity of coke charged into the generators of a calorific value of 100 therms (an amount sufficient to produce 22,700 c.ft. of gas), the thermal distribution is:

1.—8 therms lost in radiation and convection, in hot ashes, and in coke dust in blast products.

2.—10·3 therms lost in the sensible heat of blast gases escaping.

3.—The producer gas necessarily formed in blowing and normally passing away unburnt has a potential combustion energy of 15·6 therms. When the gas is carburetted by oil, a proportion of this (up to 4 therms) is employed for carburettor heating.

4.—6·1 therms passing away as sensible heat in the water gas made.

5.—There is a further charge on the plant equal to 27 therms as fuel used in the steam-raising plant. Of this amount, 7 therms are lost in the boiler plant, 8·1 therms go to the generators as reaction steam, and 11·9 therms as steam for driving the gas exhausters, blowers, pumps, &c. The calorific value of the uncarburetted gas produced is 68·1 therms; an overall efficiency of 53 p.ct. being thus attained. When the gas is carburetted, the thermal efficiency rises towards 65 p.ct., as the gasification of the oil is effected at a high efficiency.

With a loss of 39 p.ct. of the original energy, waste heat recovery is becoming standard practice in America and in this country. At the Fulham works, one such boiler has been in

operation nearly two years, evaporating up to 800 gallons per hour, with entire absence of operation trouble.

Two cases arise:

(*a*) *Blue Water Gas.*—In this process the whole of the issuing gases can be passed through the boiler, and the losses (2), (3), and (4), totalling 32 therms, absorbed in part; the gases leaving the boiler at 400° Fahr. And 22·7 therms are recovered as steam, equal to 90 lbs. per 1000 c.ft. The plant steam requirements being only 20 therms, or 79 lbs. per 1000 c.ft., the boiler will generate more than the requisite amount of steam, resulting in an over-all gasification efficiency of 68 to 70 p.ct. The actual saving thus effected is over 2d. per 1000 c.ft. of gas, or 0·66d. per therm of gas produced, which repays the cost of the installation in just over two years.

(*b*) *Carburetted Water Gas.*—Boilers are working in America to utilize the whole of the heat wasted in this process; the yield being 80 lbs. of high-pressure steam per 1000 c.ft. In general, however, it is more simple to extract heat from the blast products only, as, by reason of their temperature, they must not pass through tubes traversed by tarry gases. A considerable proportion of the steam to operate the whole plant can be obtained. Waste-heat boilers are now at work in England, on plants using 2 gallons of oil per 1000 c.ft., producing 45 to 60 lbs. of steam (at 90 lbs. pressure) per 1000 c.ft. of gas made.

WASTE-HEAT BOILERS.

All the forms of waste-heat boiler referred to are of the tubular type (often fire tubes), and, because of the conditions of heating, are large for their output. Specialist design is necessary. All this makes for higher capital costs, which, however, are offset by the entire absence of fuel charges and decreased labour cost. Maintenance and water-softening charges average the same as for ordinary water-tube boilers. The saving of 0·2d. to 0·7d. per therm usually repays the outlay in two to five years, and adoption ought to be rapid on this account, no less than the raising of gas-making efficiency to 82 p.ct. in carbonization and 70 p.ct. in gasification.

DESIDERATA IN THE QUALITIES OF TOWN'S GAS.

By JOHN SIDNEY GORDON THOMAS, D.Sc.

To be adequate, three main aspects of the question should be embraced in any discussion relating to "Desiderata in the Qualities of Town's Gas:" (1) Economic production and distribution. (2) Chemical and physical characteristics of the various products of the thermal treatment of coal. (3) Efficient utilization of the same. The conference, it is hoped, will afford an opportunity for the discussion of the question from these several standpoints.

Town's gas is the misnomer which poverty of language compels us to apply to one of the main products of the thermal treatment of coal in gas-works. Nowadays, the energy of gaseous fuel finds application in such a diversity of directions that the designation "town's," referring implicitly to the use of the commodity as administering to the communal welfare, more especially in the matter of the provision of light and heat for public and domestic purposes, is inadequate. One does not speak of town's electricity. Nor can the appellation "gas" be regarded as entirely satisfactory, as it rather serves to obscure what is of the very essence of the present discussion—namely, that town's gas is a mixture, not only of the more permanent gases, but contains also the unsaturated or saturated vapours of certain liquids, and even of solids. These two aspects of the question—the complex nature and the diversity of manners of application of the product—adumbrate the complexity of the considerations involved in arriving at a decision as to what are the desiderata in the qualities of town's gas. The recommendations of the Fuel Research Board, as embodied in the legal enactments of the Gas Regulation Act, whereby considerable latitude is permitted to gas companies throughout the country in the matter of the production of gaseous energy of a declared concentration, and whereby the onus for the efficient utilization thereof is to be borne by the gas companies, have, I think, somewhat simplified the problem.

In such a contentious matter as the present, can any fundamental postulates be made, based preferably upon consideration of natural processes, which shall serve as the lodestar to guide the gas industry in its endeavour best to serve national interests in the matter of the production of gaseous energy? "To the solid ground of Nature trusts the mind which builds for aye." I think there are at least two such postulates. From the nature of its origin, town's gas necessarily consists of certain elementary gases—oxides of carbon, hydrocarbon gases, and vapours—and small quantities of other vapours generally classed as impurities. The postulate will, I think, be accepted that the constituents of town's gas should, subject to economic considerations, be such that the products of their combustion should be carbon dioxide and water only, accompanied, if desired, by nitrogen and oxygen—products present in or discharged into the atmosphere during the operation of universally distributed natural processes, more especially those of respiration (a form of combustion) and evaporation.

The evolution of the plant kingdom has been such that such combustion entails no permanent increase in the world's supply of atmospheric carbon dioxide. The consideration advanced indicates the desirability of eliminating as completely as possible from town's gas all sulphur compounds. As an economic proposition the sulphur content of town's gas, present either as gas or vapour, can be reduced to the equivalent of about 0·03 p.ct. by weight; and more recent work has established the fact that reduction to a mere trace can be achieved industrially. Apart from certain obvious advantages accruing to this almost complete elimination of sulphur compounds, reference may here be made to the recent work of Travers,* who has shown that the clouding of soft soda-glass during lamp working employing town's gas, is attributable to the presence of minute traces of sulphur compounds in the gas.

The second postulate I would make is that, subject to considerations of economic production, the constitution of coal gas and its mode of distribution and utilization should be such as to involve the minimum of needless expenditure or degradation of energy. Natural processes are all effected in accordance with this principle, which may be conveniently referred to as the principle of least action—a bedrock principle of physical and mathematical science. One can but contrast the apparent ease with which enormous volumes of water are transported and distributed over continents in the form of clouds and rain with the difficulties inherent to the best systems that man has yet achieved in its transport and distribution over very much more moderate areas. The principle would indicate that, economic considerations of production apart, the constitution of town's gas should be such that the expenditure of energy necessary for the storage and distribution per unit of gaseous energy is a minimum, subject to the proviso that the efficiency of utilization of all degrees of concentration of gaseous energy is the same. The admirable work of the Gas Investigation Committee of the Institution of Gas Engineers leaves little doubt that, over a wide range of concentration of gaseous energy, the efficiency in the use of town's gas does not vary appreciably. This arises very largely owing to the fact—to which attention was, I think, first directed by Sir Dugald Clerk—that the actual concentration of gaseous energy in the mixture of gas and air necessary for its combustion is dependent only to a very slight degree upon the calorific concentration of the gas itself.

Subject, then, to economic conditions of production, it appears that town's gas should contain the minimum admixture of those gases classified generally as inerts, more especially nitrogen and carbon dioxide (recent investigations tend to exclude oxygen from among the inerts). There appears to be very little justification from the purely physical standpoint for employing energy for the transmission, from the point of production to the point of utilization, of gases already available in practically unlimited amount

* Society of Glass Technology, March 16, 1921.

APPENDIX.

Constituent.	Density.		Volume of Air Necessary for Complete Combustion of 1 Volume of Gas.	Calorific Power per C.Ft. (dry) at 60° Fahr. and 30 in. Pressure. B.Th.U.		Concentration of Calorific Energy in Mixture for Complete Combustion (B.Th.U. Gross per C.Ft.)	Theoretical Temperature Attainable by Complete Combustion (°C.) with Air, Assuming Absence of Dissociation.	Volume of Products of Combustion Measured at Flame Temperature Derived from Combustion of 1 vol. of Gas.	Concentration of Calorific Energy per Unit Volume of the Products of Combustion (Net.)	Percentage of Gas Contained in Explosive Mixture with Air.		Maximum Velocity of Propagation of Flame, in Mixture of Gas with Air (in the 2·5 cm. dia.)—cm./sec.	Percentage of Gas Present in Mixture in which Flame is Propagated with Maximum Velocity.	Percentage of Gas Present in Mixture for Complete Combustion.	Percentage of Thermal Radiation from Non-Luminous Flame.	Wave Length corresponding to Maximum of Principal Band of Infra-Red Emission Spectrum (10—4 cm.)	Relative Intensities of Infra-Red Radiation due to Combustion in Flame.
	Grms. per litre at 0° C. and 760 mm.	Air = 1		Gross.	Net.					Min.	Max.						
													Per Cent.	Per Cent.	Per Cent.		
Carbon monoxide	1·2504	0·9672	2·38	323·5	323·5	95·7	2100	25·0	12·9	12·3	75·0	60	45—50	29·5	8·74	4·32	3
Hydrogen . . .	0·08987	0·06952	2·38	325·2	271·9	96·2	1960	23·6	11·5	4·2	75·0	480	38	29·5	3·63	2·61	1
Methane . . .	0·7168	0·5544	9·52	1017·0	911·0	95·7	1830	81·0	11·2	5·5	13·3	66	9·5	9·5	5·15	..	..
Ethylene . . .	1·274	0·985	14·3	1599·0	1491·0	104·5	2200	138·0	10·8	4·0	15·0	..	..	..	5·12	..	..
Benzene . . .	3·482	2·694	35·7	3699·0	3542·0	100·8	2460	372·0	9·5	2·5	6·5	..	..	..	..	..	..

at the latter place. If merely carrying coals to Newcastle is inadvisable, what shall be said of delivering dross at that port? At the present stage of the evolution of the gas industry, however, it appears undesirable that any legal restriction should be placed upon the permissible percentage of inerts present in town's gas. The consumer is efficiently protected by the "declared calorific value" of the gas; and the gas company has to safeguard that the consumers' appliances are such that the gaseous energy, of the concentration supplied, may be efficiently utilized. It appears, therefore, that the question of the possible legal enactment of a limitation in the permissible percentage of inerts in town's gas must wait upon further investigation into the economic production of gaseous energy—a conclusion in keeping with the liberty intended to be conferred upon the gas industry by the recent recommendations of the Fuel Research Board.

Naphthalene and cyanogen should be eliminated as completely as possible, owing to the difficulties of distributing and utilizing town's gas due to their presence.

Should any restriction be laid upon the permissible percentages of the various combustible constituents present in town's gas? It seems to be generally overlooked that the possibility of almost infinite variation in the constitution of town's gas confers upon the commodity a flexibility in application not possessed by its keenest competitor—electrical energy. The actual composition of town's gas can be varied within wide limits; the mixture remaining of constant calorific value. If the operation of consumers' appliances at the maximum efficiency requires the utilization of gaseous energy at a definite constant hourly rate, then constancy of calorific value must be accompanied by constancy of the ratio of the pressure of supply to the density of the gas supplied. If, as seems desirable from a variety of considerations, the pressure of supply is maintained constant, then the density of the supply should be maintained as constant as possible. Subject to this proviso, I see no reason why, at the present stage in the evolution of the gas industry, any restriction of the nature referred to should be imposed upon the industry.

The physical constants relating to the principal combustible constituents of coal gas, given in the appendix, will, it is hoped, be of value in the discussion.

INSTITUTION OF MECHANICAL ENGINEERS.

Improving the Thermal Efficiency of Heat Power Plants.

The summer meeting of the Institution is, as has already been stated, to be in the nature of an informal conference, on Thursday and Friday of this week, upon "Means of Improving the Thermal Efficiency of Heat Power Plants." The conference will be held in the Institution's building, Storey's Gate, S.W., under the presidency of Captain H. Riall Sankey, C.B., C.B.E.; and concurrently with it there will be an exhibition of apparatus, models, diagrams, &c. A number of visits have also been arranged—among them, on Thursday afternoon, to the Department of Chemical Technology, of the Imperial College of Science and Technology, under the guidance of Prof. W. A. Bone and Prof. J. W. Hinchley, and, on Friday afternoon, to the Fuel Research Station at East Greenwich.

Two of the papers to be read and discussed to-morrow [Thursday] morning will be of special interest to "JOURNAL" readers. Mr. E. V. Evans, O.B.E., F.I.C., of the South Metropolitan Gas Company, in a paper on the "Chemistry of Combustion," will discuss the bearing of modern research on the mode of combustion in producer and furnace gas reactions, with particular reference to the part played by carbon monoxide. Prof. W. A. Bone, D.Sc., F.R.S., will deal with the "Low-Temperature Carbonization of Coal," and emphasize its importance in relation to (*a*) smoke abatement in domestic consumption and (*b*) our future oil-fuel supplies. He will give comparative fuel costs "per therm of radiation" from electric radiators, gas-fires, and open fireplaces burning either raw coal or semi-coke, and argue that gas undertakings may in future periods find it profitable to revert to something near the practice of a century ago, and manufacture a smokeless "semi-coke," *plus* a rich gas for domestic consumption. On Friday morning, Mr. Robert Nelson will open a discussion on "Waste-Heat Utilization."

SIXTY YEARS AGO.

[From the "Journal" for June, 1861.]

Scotland and Cheap Gas.—The monotony of the cheap gas movement in Scotland has been enlivened by the introduction of some personal attacks, which Mr. Flintoff has excited by his reckless charges against gas companies and those who are concerned with them. He was invited to the small town of Musselburgh, about five miles from Edinburgh; and in that retired locality he gave vent to more random talk than he had previously ventured to utter in Edinburgh or Leith. But, unfortunately for him, one of his hearers happened to be an experienced gas manager, who boldly denied Mr. Flintoff's assertions, and offered to prove that they were fallacious. He did not, however, obtain a very patient hearing, and he has since replied to Mr. Flintoff in print. The antagonist thus called forth is Mr. Young, the Manager of the Dalkeith Gas-Works, who brings forward some of Mr. Flintoff's antecedents, for the purpose of showing that the "gas engineer" who declares that the Scotch gas managers know nothing about their business, has gained his own knowledge of gas affairs within the last ten years, and that in the course of this brief period some of his attempts to lower the price and improve the quality of the gas by agitation have been complete failures. Mr. Young seems to know his man; and he has dealt with him so smartly that we expect it will serve as a lesson to Mr. Flintoff to be more cautious in his future assertions. If we may judge of the success of his mission to Edinburgh by its fruits, it is not much to boast of. The sums collected in aid of the cheap gas movement, by the Gas Consumers' Association, do not amount to more than £27. With this fund in hand, the Association advertise for tenders for 1,000,000 bricks, 100 miles of cast-iron pipes, 500 tons of iron castings, 250 clay retorts, and for an annual supply of 50,000 tons of cannel coal. We need not add a word more to show that the threatened formation of a new gas-works is a mere *brutum fulmen*.

Coal-Tar Colours.—The interesting paper read by Mr. Perkin before the Chemical Society, on the "Colouring Matters Derived from Coal Tar" is an elaborate exposition of the present state of our knowledge on a subject which threatens to effect a complete revolution in the source from whence our most brilliant dyes will be for the future obtained. Since Mr. Perkin's paper was read, the "Comptes Rendus" of the Académie des Sciences announces the discovery, by M. Roussin, of a process by which brilliant red, violet, and blue colours are obtained from naphthalene. There, however, still remains a great deal to be done in utilizing the other products of coal tar, such as the dead oil and pitch, and generally in the mode of conducting this new manufacture, so that the tar produced in the small gas-works may acquire some value, instead of being, as it now is considered, a drug and an encumbrance.

NATIONAL PHYSICAL LABORATORY.

Report for the Year 1920.

At the time of the presentation of the report for 1919 of the Executive Committee to the General Board of the National Physical Laboratory, the position of Vice-Chairman of the General Board was vacant, owing to the death of Lord Rayleigh. The President of the Royal Society is *ex-officio* Chairman of the General Board and of the Executive Committee. The Vice-Chairman of the Board is also Vice-Chairman of the Executive Committee. This position was filled in January of the present year by the appointment of Sir Arthur Schuster, who, as a former Secretary of the Royal Society, and in other ways, has been closely connected with the Laboratory since its foundation. This announcement is contained in the report of the Committee for the past year, wherein reference is also made to a number of other matters of importance. In connection with the suggested establishment by the Government of co-ordinating Research Boards for Physics, Chemistry, Engineering, and Radio Research, the Committee understand it is proposed to make the fullest possible use of the facilities for research which are afforded by the Laboratory.

As usual, the record of work done under the supervision of the Director, Sir J. E. Petavel, K.B.E., D.Sc., F.R.S., is a lengthy one; and full details will be found in the report, which is published by H.M. Stationery Office, at the price of 5s. net. In the Photometry Division, a considerable number of special investigations are in hand. Work has been carried out with a view to the improvement of the daylight lighting in some portions of the National Portrait Gallery; and experiments are in progress for the specification of suitable lighting schemes for public buildings and offices. Investigations have also been carried out with regard to the lighting of the Houses of Parliament. Measurements were made at many points in both chambers, with the result that the illumination of the House of Commons especially was found to be very low—less, on the average, than the equivalent of one candle at a foot. It is usually considered that three or four times as much should be provided for easy reading of such matter as manuscript, notes, &c. In the Engineering Department, further results of interest have been obtained in the research on lubricants and lubrication. The special investigations concluded during the year include tests on gas cylinders for the Gas Cylinders Committee of the Department of Scientific and Industrial Research.

With reference to the current year, it is stated that work is proceeding with the new optical pyrometer of the disappearing filament type, which is needed in connection with an international comparison of high-temperature standards. It is intended to devote some time at the earliest opportunity to investigating the most suitable methods of production of spectral illuminants from the special point of view of the optical laboratory. When drawing-up their report for 1920, the Committee mentioned it was proposed that the International Commission on Illumination should meet early this year, when the Commission would probably initiate work on a primary standard of light, as well as a new international comparison of standards. Additional work will be required by the Home Office Committee on Factory Lighting, who have resumed their meetings. In the matter of public buildings, the report recognizes that it is important that adequate lighting should be provided for the many different kinds of work; and that this can only be economically done by using a recognized schedule of illumination for different classes of employment

FUEL PROBLEMS OF THE FUTURE.

By Sir GEORGE T. BEILBY, F.R.S.

Below is given the text of the twenty-seventh James Forrest Lecture, which was delivered last evening by Sir George T. Beilby, F.R.S., in the theatre of the Institution of Civil Engineers.

Civilization on its physical side is based on fuel. Of all the powers of Nature which have been turned to his use and convenience by man, "Fire" stands out with a distinction which is unique. The kindling of the first fire of dried leaves and branches by our prehistoric ancestors, marked the beginning of the transfer of this mighty power from the gods to man; and new possibilities of prodigious import were opened up. With fire at his command, a new dividing line was established between man and the lower animals, and a higher and more social standard of living became possible. The horrors and dangers of the darkness of night were greatly mitigated, social instincts were aroused through the nightly gathering round this new source of light and warmth, while imagination and thought were stimulated. The charred stick supplied the budding artist with his first pencil; while the glowing embers were the laboratory furnace in which the coming chemists and metallurgists made their first observations on the effects of heat on rocks and stones.

Fire—first automatically and then deliberately—became the test to which all materials were submitted. The arts of the craftsman were based on these observations; the smelting of metals, the bending of wood, the singeing of skins, the melting of gums, and the boiling of water, started a whole train of new possibilities—each step in discovery opening the way to new adventures. It is no exaggeration to say that the practice of observation and experiment on which the physical science of to-day is founded had their origin in the first fire kindled by man.

In the management of the wood fire the first lessons in the properties of fuel were learned. The flaming stage, followed by the steady and more concentrated heat of the glowing embers, naturally led to the collection of more massive embers by the control of the earlier stages of combustion—thus leading up to charcoal burning, by which the worker in metals was supplied with an ideal fuel for his operations. Thus the carbonization of raw fuel as a means of raising the availability of the potential therms it contains, had its origin in the remote past.

It is far from our present purpose to follow through the ages the romantic history of the association of fuel with civilization. Enough has been said to justify my opening remark that civilization on its physical side is based on fuel. This interrelation has developed new features during and since the war; and the future production and use of fuel in this country has become closely associated with social ideals which involve the raising of the standard of living among the mining class. This, indeed, is the most pressing of the fuel problems of the near future. Can coal again be produced at a price which will enable this country to take its place in the markets of the world, while the present standards of wages and working hours are maintained? Careful and impartial students of the economic facts of the situation tell us that this is not possible. Merely to regain an entrance into the iron and steel markets of the world, we are assured that the coal used in this industry must not cost more than 18s. to 20s. per ton. For the great transport services of the country a slightly higher cost for coal might be faced if all the available measures of economy in its use as fuel are adopted. It is obvious that, without a greatly increased output per man, the earnings of the miner cannot be maintained at their present figure.

This end can only be attained by genuine co-operation between the coalowners and the miners; any half-heartedness on either side will in the long run lead to failure. How is such co-operation to be secured? The miners have pinned their faith to nationalization as supplying the solution of the problem. The nationalization which the more extreme section have in view appears to involve the handing-over of the direction and control of the industry to nominees of their own, who would in effect be pledged to regard the wage-earners' interests as paramount.

While the nation is in sympathy with the raising of the standard of living of the miners, and the improvement of working conditions in the mines, it has no belief that nationalization would supply a commonsense and practical solution of the problem. The nation also realizes that no system of bureaucratic control would adequately replace the individual and collective effort which is necessary for the development of this complicated industry.

The significance of the patience and self-sacrifice of the consumers of coal right through the difficult times which culminated in the strike of the past months, appears to have been missed or misinterpreted by both miners and mine-owners, and to some extent also by the Government. This remarkable patience on the part of the whole British public does not mean that they are either ignorant of, or indifferent to, the future availability and cost to them of the fuel on which their daily lives must depend both directly and indirectly. If a permanently higher cost of fuel must be faced, then its availability must be correspondingly increased.

To take only one aspect of this question of "availability" which affects every consumer, from the highest to the lowest—the quality of the coal as it is raised to the surface and distributed by rail and road—this is a matter which at present is entirely in the hands of the mine-owners and the miners. Every householder knows that the quality of the coal he or she receives has greatly deteriorated during and since the war. Stones and other inferior materials have been received and paid for as coal at the greatly enhanced prices of the day. The very fact that this burden is most widely felt by individuals renders it unsuitable for dealing with by statistics. For our present purpose, therefore, the experiences of the large consumers can be more usefully considered.

The gas undertakings of the United Kingdom are responsible for the distribution of the heat derived from about 20 million tons of coal per annum. This in round numbers is not less than one-eighth of the total amount of coal consumed in the country. The experiences of these undertakings as regards the depreciation in the quality of coal they have received during and since the war have been freely disclosed and discussed by their engineers and directors; and on the strength of these representations the Board of Trade agreed to sanction a very substantial reduction in the calorific value of the gas delivered and paid for at the old rates by the consumers. Even with this relaxation in quality, the gas undertakings found it difficult, and in some cases impossible, to maintain adequate supplies of gas to their consumers, while the coke in which the whole of the inert and valueless material in the coal was concentrated was rendered greatly inferior as a fuel.

During the inquiry of the Fuel Research Board into the question of gas standards, they were in close touch with this subject; and my present remarks are based on first-hand knowledge. As a result of our recommendations, the Board of Trade adopted the "therm" of 100,000 B.Th.U. as the future unit of charge to the consumer for the gas he receives; and I merely refer to the change at this stage in order to demonstrate the logical application of this principle to the question of the quality and price of coal. If the gas undertaking is in future to be paid only for the therms delivered to the customer, it is entitled to throw at least a portion of its responsibility on the coalowners and miners by paying only for the potential therms received in the coal, and not for inert and inferior materials which are not only valueless and detrimental to economical working in the retort-house, but lower the value of the coke produced.

Among other large consumers of coal, electricity generating stations occupy a very important place. Of the total cost per unit in the generation of electricity, the larger proportion is due to the fuel consumed. This cost has been trebled or even quadrupled since 1914—largely, no doubt, owing to the direct rise in the price of coal, but also to a substantial extent through the deterioration in quality of the coal supplied. By the kindness of Sir Alexander Kennedy and of Mr. Herbert Jones, the Electrical Engineer of the London and South Western Railway, I am in possession of the working results of the first quarter at two important generating stations in London. These figures will be again referred to in another connection. For our present purpose, I will only draw attention to the coal experiences at these stations. In the case of the Central Electric Supply Company, the calorific value of the coal received for thirteen weeks averaged 10,582 B.Th.U., cost 45s. 2d., per ton, and its ash content was 18·4 p.ct. The weekly ash figures ranged from 16·3 to 20·1 p.ct. In the winter of 1914-15, the corresponding figures were: Calorific value, 10,800 B.Th.U.; cost per ton, 14s. 6d.; ash content, 13 p.ct. The ash excess on the coal supply during the present year was therefore 5·4 p.ct., or rather more than 1 cwt. per ton.

At the Durnsford Road power house of the London and South-Western Railway at Wimbledon, the average calorific value of the coal received was 10,900 B.Th.U., and the ash content 16 p.ct.

Examples of this kind could be multiplied indefinitely from the experiences of private firms and public institutions. But the foregoing are sufficient to establish my point, which is that in view of the stage reached by the national coal problem, the time has come when the vital interests of the consumers must be reckoned with in any settlement that is arrived at. These interests require that the mine-owners and miners must alike realize that their responsibility is not met by the output of mere material at the pit head and its distribution to consumers by road or rail. Whether this material is to be consumed in its raw state as fuel, or whether it is to be converted into fuels of higher availability by gas-works or other carbonizing and gasifying agencies, what counts is its thermal value. To the miner it may seem a revolutionary proposal that he should be paid by the therms he sends to the surface; but as he himself possesses views in connection with the development of his industry involving a treatment of the national fuel problem from an entirely new and revolutionary point of view, he cannot logically ignore the effects on the consumer and on the nation at large of the permanently increased cost of fuel which must result if his claims for a higher standard of living are to be realized.

To my mind, it would be a serious set-back to our civilization if the only solution of the economic problem involves the

production of coal at prices which are insufficient to ensure for the miner a steady amelioration of the conditions under which he lives and brings-up his family; and I for one would be prepared with good heart to face the working-out of the more efficient use of fuel which is absolutely necessary if a higher price is to paid for coal. This, however, would only be on one condition—that there is genuine co-operation of coalowners and miners, not only in the organization of output on modern lines, but in the endeavour so to sort-out and prepare the output by screening and washing the coal at the pit-head that the consumer is only called upon to pay carriage on the actual fuel value received. The gas or electric undertakings are certainly entitled to press home to the miner the fact that, as the consumers of gas and electricity only pay them for "therms" or "units" received, they in turn should pay the coalowners and miners on the same basis, though at a cost per therm which will leave a reasonable margin of profit on their operations.

Probably the iron and steel industry will be most severely handicapped by any permanent increase in the price of coal, as fuel enters into its operations to so large an extent. The opinion has been expressed by experts in this industry that, though a reduction to 18s. or 20s. per ton in the price of coal suitable for the making of iron and steel might enable the industry to recommence, it is doubtful whether it could ultimately hold its own in the markets of the world. To ensure this, it is considered that it would be necessary for coal to return to the neighbourhood of its pre-war price. It has been suggested (Coal Conservation Committee, Ministry of Reconstruction, 1918, pp. 77-81) that a considerable saving of fuel might be effected by so grouping the elements engaged in the production of finished steel—coke-ovens, blast-furnaces, gas-producers, steel-furnaces, and rolling-mills—that the heat from all sources could be pooled at a common centre of heat and power. By this means it was considered that any excess of heat available at one stage might be made available at other stages in which an excessive demand existed. In this way it was believed that the consumption of coal per ton of finished steel might be reduced to 35 cwt. per ton. If an ordinary figure of consumption of 45 cwt. be taken, then a saving of 10 cwt. of coal per ton of steel might result from grouping. With coal at 18s. per ton the saving would amount to 9s. per ton of steel. But this estimate takes no account of the large capital which would have to be sunk in scrapping and replacing existing works.

The future of British iron and steel production is obviously so closely associated with the future price of coal, that no outsider is in a position to solve the problem. We can say, however, that substantial fuel economies are possible, though the extent to which this would justify a higher price for coal is still quite uncertain.

Before considering in technical detail some of the fuel problems which are more immediately before us, it may be well to pass in review the fuel position of the world, as it is disclosed by the most recent figures of production. For our present purposes our survey must be on broad and simple lines, which will enable us to grasp the whole question in due proportion and in its true perspective. Proportion and perspective, as the exponents of the doctrine of relativity might remind us, depend entirely on the point of view of the observer. The facts and figures of the fuel resources of the world are the common property of the experts of all civilized nations. They may be regarded as being like the immutable laws of Nature; but the proportion and perspective in which these facts and figures range themselves are different for the observers and commentators of each of these nations. In our own survey, we shall be wise to have in our minds some recognition of these widely different points of view.

In Great Britain, as a maritime nation, we cannot, either on political or commercial grounds, ignore the points of view of other nations inside or outside the circle of the Empire.

An interesting review of the world's coal supply in 1920 is given in the United States Geological Survey. The total output, including brown coal and lignite, amounted to 1300 million metric tons. This is within 3 p.ct. of the maximum output which was reached in 1913 and 1918. Of this total output—

The United States of America produced	45 p.ct.
Great Britain and the British Empire produced	22 ,,
Germany produced	19 ,,
Other countries, ranging from 2½ p.ct. downwards, produced	14 ,,
	100 ,,

One of the most significant features revealed by this survey is the remarkably rapid development in the winning and use of brown coal and lignite in Europe and particularly Germany. The output in Germany in 1919 had reached the huge figure of 93·8 million tons; but this was overtopped in 1920 by an output of 111·6 million tons—an increase in one year of nearly 18 million tons. The total European output in 1920 amounted to 140·7 million tons, made up as follows:

Germany	111·6 million tons
Czecho-Slovakia	19·7 ,, ,,
Jugo-Slovakia	2·5 ,, ,,
Austria	2·4 ,, ,,
Italy	1·6 ,, ,,
Netherlands	1·4 ,, ,,
France	1·0 ,, ,,
Spain	0·5 ,, ,,

The output of ordinary coal in Germany for 1920 was 140·8 million tons. The brown coal industry in that country is of old standing; and its rapid development in recent years is based on sound knowledge and experience. Though in its natural state a less concentrated fuel than bituminous or anthracite coal, brown coal has many points in its favour. The chief of these is the low cost at which it can be won as compared with ordinary coal. Where extensive deposits of great thickness occur, these can be worked opencast, and excavated by machinery. The winning of brown coal is thus on an altogether different basis from coal mining, with its deep and costly underground roads and workings, which involve heavy costs for timbering, pumping, and ventilation. The manual labour required is much smaller in amount for a given output, and is of a less highly specialized type; while the special dangers and uncertainties of coal mining are practically absent. The capital charges—being mainly on surface roads and on excavating machinery—are relatively light, as compared with the heavy initial and permanent charges involved in the sinking and equipment of shafts or mines. Brown coal, though it contains from 40 to 60 p.ct. of water, is to-day by far the cheapest source of thermal units. Its further manufacture by drying, briquetting, and carbonization can be carried out close to the point of excavation, and under conditions favourable to production on a large scale, and therefore at a low cost.

The glowing accounts of this development which have appeared in the Technical Press during the past two years may have struck us as exaggerated; but the solid fact remains that the output of lignite in Germany last year was 111 million tons. Germany has already faced the fuel problem of the future so far as she herself is concerned!

In view of the hard facts and figures which are now before us, it is not surprising that Germany's example is being followed, not only in Central Europe, but in Victoria and in Canada. In Victoria, extensive deposits of brown coal exist in Central Gippsland, which are estimated by Mr. H. Herman, the Director of Geological Survey, to contain 30,000 million tons. The main deposits near Morwell are hundreds of feet in thickness, and lend themselves admirably to opencast working on an enormous scale. Considerable progress has already been made in the development of these deposits; and since the commencement of operations in 1916, 400,000 tons of brown coal have been mined and sold. When the excavating methods become more perfectly organized, it is anticipated that the coal will be produced at the mines at 2s. 3d. per ton. It contains from 40 to 50 p.ct. of water; so that in heat value two tons is equal to about one ton of ordinary coal. A 50,000 kilowatt generating station is being installed at Morwell for the transmission of current to Melbourne. Though a considerable market appears to exist for the coal as it is mined, it is intended to establish briquetting and carbonizing plant at the mines; so that fuels of higher availability will be produced from the raw coal. In 1920, a sample of this coal was received here, and experiments on its carbonization were carried out at the Fuel Research Station.

In the Dominion of Canada, experiments are in progress on the briquetting and carbonization of the brown coals of Manitoba and Saskatchewan. These experiments are being carried out under the auspices of the Dominion Government and of the Government of the Province of Saskatchewan.

Somewhat allied to the lignite problem is that of the development of peat as a fuel. The Dominion Government of Canada is keenly interested in this question; and I shall have something more to say on the subject at a later stage. Germany also is preparing for important developments, some of which are described in the "Engineer" for April 22, 1921. The Wiesmoor plant, which has been in use since 1910, is now regarded as obsolete; but during the ten years it has been in use, much valuable experience has been gained in the winning and use of peat. The average fuel consumption is stated to be from 2·7 to 3 kilos. of partially dried peat sods per K.W.-hour, and the cost of the peat is taken at 5 marks per ton. It is now proposed to establish a line of generating stations fired by peat extending from Königsberg in the east to Wiesmoor in the west.

The world's output of brown coal and lignite in 1920 was about 143 million tons, or 11 p.ct. of the total coal output of 1300 million tons. From the European point of view the significance of this fact must not be gauged in terms of this moderate percentage. According to the extent to which Germany can meet her own requirements for heat and power by the development of lignite, peat, and water power, the output of her coal mines will be set free for export, and she will thus take a more important place in the markets of the world. The coalowners and miners of this country would be well advised to keep an eye on the development of brown coal and lignite in Germany and elsewhere.

Turning now to oil, the other great natural source of fuel, we find that the world's output for 1920 was about 97 million tons, of which—

The United States produced	64·8 p.ct.
Mexico	23·3 ,,
Russia	3·5 ,,
Dutch East Indies	2·5 ,,
India	1·2 ,,
Roumania	1·1 ,,
Persia	1·0 ,,
Countries producing less than 5 p.ct.	2·6 ,,
	100·0 ,,

The oil output therefore amounted to 7 p.ct. of the fuel output of the world, reckoned in tons. If reckoned in potential therms, the figure would be raised to 10 p.ct.

As the United States has extensive oil interests in Mexico, it

may be taken that last year she controlled 75 to 80 p.ct. of the total output of the world. It is therefore significant that, in official quarters, grave anxiety has been expressed as to the probable exhaustion of these resources in view of the rapid development in the use of motor spirit for road transport and of fuel oil for transport by sea.

While we are justified in discounting to some extent the elements of popular panic which have been obvious in much that has appeared in Technical Journals, as well as in the Daily Press, the fact remains that, but for the rapid development of production in Mexico, and the extensive interests of the United States in this production, the actual danger of shortage in America would have already become more acute.

The following extract from a statement by Mr. J. O. Lewis, Chief Petroleum Technologist to the United States Bureau of Mines, expresses so very clearly the American view of the oil problem of the future that I cannot do better than quote it *in extenso*. No mere paraphrase would convey the same impression of reality.

The United States Geological Survey during the last ten years has made several estimates of the quantity of oil left in our old fields. The most recent estimate—that of David White—indicates that about 40 p.ct. of the oil had been brought to the surface, and that the 60 p.ct. remaining underground, if recovery as needed were possible, would last barely 20 years at the present rate of consumption. As the period in which an oil field can be made to yield its oil is not wholly within the control of man, the domestic production will undoubtedly be spread over a much longer period than that estimated; but, on the other hand, the peak of production will be passed long before 20 years, and thereafter production will be at a declining rate. Of course, such estimates are by no means infallible, as many obscure factors are involved. However, this statement represents the opinion of the agency best qualified to make such an estimate, and is indicative of a condition which, were there no other solution to the problem, would be highly unsatisfactory, and would be viewed by the automotive industry with the greatest concern. For, even were the estimate unduly pessimistic, and the actual reserve twice that shown, the condition would still be unsatisfactory.

The preceding statement refers only to the oil from oil wells in the United States. Fortunately, there are enormous undeveloped resources in the rest of the world. The petroleum resources of this country have been developed and depleted in a ratio far beyond that of other countries, so that although we are producing to-day two-thirds of the world's production, the opportunities elsewhere for increasing production are much greater than in the United States. Geologists and those well informed on foreign resources believe that in all probability the world contains enormous reserves of oil that can be obtained upon demand. Although to obtain oil from these reserves may not be as satisfactory as to obtain it within the confines of the United States, the outlook tends to assure the future of the internal combustion engine.

Fortunately, oil may be obtained from other sources than oil fields. In various parts of the United States, particularly in Colorado, Wyoming, and Utah, are enormous bodies of oil shales from which oil may be obtained by destructive distillation as benzole is obtained from coal. The United States Geological Survey has estimated the quantity of oil locked-up in the richer shales of the three States mentioned as perhaps ten times the amount of the oil reserve in the oil fields. In Scotland, the retorting of oil from oil shales has been on a commercial basis for more than fifty years, and antedates the oil industry in the United States. Commercial and semi-commercial experiments are being made in order to determine whether the oil shales of the Western States can be mined and retorted profitably in competition with petroleum from oil fields. This problem has not yet been solved; but these shales constitute a latent reserve that protects the future needs of the country for motor fuel as far as these needs can be foreseen. However, oil cannot be obtained from the shales on a large scale without heavy investments; and the development of the industry must be spread over many years. Also, when that time comes, the consumer will probably have to pay more for his gasoline.

As regards the question of substitutes, if prices of petroleum products advance sufficiently, alcohol may become one of the motor fuels of the future. The efficient use of alcohol requires, however, certain modifications in the present design of the mobile internal combustion motor. Moreover, large quantities of lubricants are required, in addition to motor fuel. Hence it seems desirable to continue to depend on crude oil as a principal source as long as possible, especially as crude oil is the only known satisfactory raw material yielding both motor fuel and lubricants.

Briefly, motor fuels may be obtained from four possible sources: (1) Petroleum from our own wells; (2) petroleum from wells in foreign countries; (3) oil from our oil shales; (4) gasoline substitutes. As to the first, there is serious but not immediate concern. As to the second, it is believed that there remain enormous potential reserves outside the United States. As to the third, there are known deposits of oil shales which, in three States alone, promise to yield many times more oil than will ever be recovered from our oil wells. As to the fourth, it is probable that eventually alcohol could meet our needs should gasoline fail. Thus, while there is concern over our own domestic supplies of petroleum from oil wells, there is no concern as to the ultimate supply. There may be critical periods when one source fails, and before another has been developed; also it is not unlikely that when our own wells fail, and we have to fall back on oil from foreign countries or oil shales, we shall have to pay more for our motor fuel.

In view of this reference to alcohol as a probable substitute for motor spirit, it may be well here to refer to the action of the British Government in this connection.

In view of the national importance of the subject, Mr. Walter Long appointed a Committee in October, 1918, to report upon:

(1) The various available sources of supply of alcohol, the methods of manufacture, and the cost of the product.

(2) The suitability of alcohol, either alone in admixture with solid, liquid, or gaseous combustible substances, for use in internal combustion engines, and the modifications of the existing types of such engines which may be necessary to the attainment of efficiency.

(3) The question of denaturing the alcohol, and the alterations to be made in the present Excise Bill.

The Committee obtained much useful information of a preliminary nature; and in June, 1919, they issued a report which was presented to Parliament on June 30.

One of the recommendations of the report was: "That an organization should be established by the Government to initiate and supervise experimental and practical development work, at home and overseas, on the production and utilization of power alcohol, and to report from time to time for public information on all scientific, technical, and economic problems connected therewith."

This report was in due course considered by the Committee of Council for Scientific and Industrial Research, who recommended the Fuel Research Board to continue the investigation of the problems.

As a first step in these inquiries, the Fuel Research Board recommended the appointment of Sir Frederic Nathan as Power Alcohol Investigation Officer. This appointment was confirmed by the Lord President on Dec. 17, 1919. Since his appointment Sir Frederic Nathan has devoted his whole time to these inquiries, and has been in close touch with the Government Departments interested in the questions involved.

In July, 1920, an Interim Memorandum on "Fuel for Motor Transport was published by the Fuel Research Board, in which the situation at that date was summed up as follows:

The main sources of alcohol are vegetable materials containing starch or sugar; and practically all the alcohol for potable and industrial purposes is now made from grains or molasses. Before the war large quantities of alcohol were made in Germany from potatoes specially grown for the purpose.

Alcohol can also be produced from the fermentable sugars formed by the hydrolysis of wood cellulose, and synthetically from calcium carbide or from the ethylene contained in coke-oven and coal gas. The quantity of waste wood in this country for alcohol production is, however, negligible. Calcium carbide is impossible, as it cannot be produced in quantity without cheap power; and the recovery of ethylene from coke-oven and coal gas, and its conversion into alcohol, are still in the experimental stage. At the present time, therefore, none of these three sources of supply is of appreciable commercial importance in this country.

The vegetable materials growable in this country from which alcohol could be made are grain [barley], potatoes, and mangolds; and the following figures relating to the production of 250 million gallons of 95 p.ct. alcohol are interesting:

—	Quantities.		Acreage.*		Raw Material.	
	Required for 250 Million Gallons.	United Kingdom Production, 1919.	Required for 250 Million Gallons.†	Under Crop in 1919.	Average Price per Ton, 1919.	Cost per Gallon of Alcohol.
	Tons.	Tons.			£ s. d.	s. d.
Grain (barley)	4,170,000	1,288,035	5,593,293	1,870,087	21 4 0	7 0
Potatoes	12,500,000	6,312,000	2,118,644	1,218,774	8 10 6	8 6
Mangolds	25,000,000	7,769,000	1,282,513	471,759	1 10 0	3 0

* Total arable acreage of the United Kingdom—about 21 million acres.
† Based on ten years' average yields.

These figures are not encouraging; and generally it may be stated that the production of alcohol in any considerable quantities from vegetable materials grown in the United Kingdom is not economically possible owing to: (1) Insufficient acreage; the high cost of cultivation and harvesting; (3) the high cost of manufacture; and (4) the fact that the most suitable raw materials are also important foodstuffs. There is for these reasons no prospect of replacing any considerable quantity of petrol by home-produced alcohol. Moreover, it is unthinkable that land, for even a fraction of the quantity of the raw materials in the above table, could be used for such a purpose, when in the matter of food production, a week-end supply only is assured from our own land.

Considering next the production in the Empire outside the United Kingdom, molasses is the raw material which can be converted into alcohol most cheaply. Molasses is a bye-product of sugar refining; and the quantities available for the manufacture of alcohol are therefore dependent on the refined sugar output. The estimated Empire production of refined sugar in the season 1919-20 is just over one million tons; and the whole of the resulting molasses would only produce about 17 to 18 million gallons of 95 p.ct. alcohol. Considerable quantities of molasses are used in this country for the manufacture of industrial spirits. The output of the home distilleries equipped for the production of molasses alcohol is limited, however, to (say) some 7 or 8 million gallons of 95 p.ct. alcohol; and, in view of the present cost of materials and labour and of freight, it would hardly be a commercial proposition to erect additional distilleries here for the purpose. It would be better to convert the molasses into alcohol where it is produced, to use the alcohol where it is made to supplement or replace petrol, and to export the balance. With the present increasing output of cane sugar, there should be very considerable quantities of molasses available for the manufacture of power alcohol; and the possibility of utilizing these molasses is being brought to the notice of the authorities of the countries concerned. Even in the most favourable circumstances, however, the quantities of power alcohol available from this

source must be (as shown above), comparatively small, and will in the first instance mainly be used in the neighbourhood of its production in replacement of petrol.

Some of the legislative questions which arise in connection with the use of alcohol for power purposes have been dealt with in the Finance Bill for this session. A section of the Bill provides for the use of a new description of methylated spirits, to be called "power methylated spirits," for generating mechanical power, and for the payment of the same allowance in respect of such methylated spirits as applies to methylated spirits used for industrial purposes—namely, 3d. a proof gallon. It also gives power to the Board of Customs and Excise to make regulations as to the composition and quantity of the denaturant. A denaturant will shortly be authorized for power methylated spirits, which it is hoped will reduce to the minimum the cost of denaturing spirits to be used for this purpose. Clauses will also be inserted in the forthcoming Revenue Bill extending facilities for the importation and distribution of spirits in bulk, and enabling the Board of Customs and Excise to make regulations providing for the use of alcohol in generating mechanical power.

While it is necessary, in view of the high duty on spirits in this country, to maintain some restrictions upon their use free of duty, one result of the Government action will be that the production and use of alcohol for power purposes will be much facilitated, and the expense connected with any necessary restrictions will largely disappear.

As regards the work of the past year, Sir Frederic Nathan reports that experiments carried out on the cultivation of Jerusalem artichokes have indicated that very good yields of alcohol per acre could be obtained from them. These experiments are being repeated this year; and if the previous year's results are confirmed, it may be desirable to consider the possibility of growing this tuber to supply a limited quantity of alcohol for special purposes, such as aviation. An examination of the artichoke stems has indicated that it may be possible to convert them by simple treatment to paper pulp. Should this prove to be the case, both products would be cheapened.

The investigation as to the possibilities of producing alcohol in the Empire overseas are still in progress. So far as they have gone, they indicate that in the sugar growing countries, molasses, from which alcohol might be obtained, is being wasted, but that the quantities are comparatively small, and in most cases would be insufficient to meet even local requirements for alcohol. Alcohol might be made from suitable crops grown specially for the purpose in those Dominions and Colonies where labour is available, and used to supplement or to take the place of supplies from the above sources. Some such course is specially desirable where petrol is dear and difficult to obtain—for instance, in the East African Protectorates and West African Colonies, which are, moreover, very dependent on motor transport for their development.

The use of cellulosic materials is not yet possible, because though research work is in hand to find a process that could be employed on a commercial scale in those regions where such materials exist in sufficient abundance, it has not so far led to any definite results. Where, however, materials capable of easy hydrolysis exist (as, for instance, in the case of waste rice-straw), the recent large-scale experiments in Burma, carried out under the auspices of the Burma Oil Company, appear to indicate that the joint production of alcohol and paper should be a commercial possibility. (*Vide* Sir Charles Bedford's Paper in the "Journal of the Royal Society of Arts," June, 1921.)

Until alcohol can be made from waste materials which can be collected and treated at small cost, it does not seem likely that Empire-produced alcohol can be imported into this country on any considerable scale; it is improbable that it can be produced cheaply enough or in sufficient quantities from materials grown for the purpose in those overseas portions of the Empire which will no doubt before long produce it in this way for local consumption.

The Finance Bill of 1921 contains clauses giving the Commissioners of Customs and Excise powers to make regulations with respect to spirits manufactured otherwise than by distillation, and with respect to the manufacture, storage, removal, sale, use, and supply of power methylated spirits, and the importation, storage, removal and use of spirits to be used in their manufacture.

Another of the fuel problems of the future is the winning and utilization of peat. The history of the association of the Fuel Research Board with this problem has been given in various publications of the Department of Scientific and Industrial Research. Among these the report of the Irish Peat Inquiry Committee, of which our past President (Sir John Purser Griffith) was the Chairman, stands out most conspicuously. This subject would in itself supply material for many lectures; but on the present occasion it can only be briefly referred to in its relation to the subject of our consideration to-night.

Reference has already been made to the extensive peat developments which are in progress in Germany. These are based on the experience gained at the Wiesmoor Peat Station, which has been in operation since 1910. The peat is dredged, macerated, and spread on the surface of the bog to dry. By stacking under cover, the moisture of the peat blocks can be reduced to 25 p.ct. solely by air-drying. It has been stated that, prior to the war, one ton of air-dried peat containing 25 p.ct. of moisture could be produced for 4 marks. For steam-raising purposes two tons of this peat are equal to about one ton of coal. At the Wiesmoor Station eight water-tube boilers are fired by peat. The new stations in Germany are being designed on a much larger scale; no effort being spared to render them as perfect as possible.

These schemes appear to ignore the fundamental difficulty which applies to the winning of peat in quantities sufficient to meet the day-by-day requirements of any large central station. When it is realized that the peat deposit in a bog 20 ft. deep is only the equivalent of a 12 or 14 in. seam of coal, it will be evident that even an output of 1000 tons a day of air-dried peat involves the laying-out and development of an enormous surface. At the Zehlonbruck plant, near Königsberg, it is proposed to use 920,000 tons per annum, or about 2500 tons per day.

Prof. Purcell informs me that to win mechanically 900,000 tons of air-dried peat in one season, at least 4500 men, women, and children would be required; and the area over which the spreading and drying operations would extend could not be less than 9000 acres, or (say) 15 square miles. He suggests that in dealing with any production over 60,000 to 80,000 tons per annum from any single district, the difficulty would increase as the square of the production.

The Irish Peat Inquiry Committee was fully informed as to the position of peat winning in Germany prior to the war, and also as to the earlier survey and investigation work of the Canadian Department of Mines. In April, 1918, a Peat Committee was set up by the Federal Government, in co-operation with the Government of the Province of Ontario, to investigate the possibility of manufacturing peat fuel on a commercial scale. The Alfred Peat Bog, on which the work of the Committee is being carried out, is about 43 miles east of Ottawa, and about 70 miles from Montreal. Last summer, Prof. Pierce Purcell, the Peat Investigation Officer of the Fuel Research Board, visited the experimental station at this bog, and carefully studied the results which had been achieved under the direction of Mr. E. V. Moore, the Engineer in charge. Prof. Purcell was able to watch the harvesting operation over a period of weeks, and obtained much useful information as to machines and methods. His discussions with Mr. Moore were most useful; and on his return to this country he presented to the Fuel Research Board an exhaustive report on his visit. During the present season Prof. Purcell hopes to visit the peat stations in Sweden, Germany, Denmark, Holland, and France. We shall thus be in intimate touch with all the more important developments which are in progress; and the Fuel Research Board hope, by continuing the publication of full reports, to serve as a useful centre of information on the subject.

With regard to the Board's own activities, these were necessarily seriously curtailed by the war and the post-war conditions in Ireland. Last season (1920), however, peat was cut, macerated, spread on the bog at Turraun, air-dried, and harvested.

At the beginning of the present year, 100 tons of this air-dried peat were sent to the Fuel Research Station, where some interesting experiments were carried out on its use for boiler firing and for carbonization. The peat when it reached the Station, contained about 27 p.ct. of moisture. After having been kept under cover for some months, the moisture was reduced to about 17 p.ct. This peat is in the form of hard blocks of various lengths, up to about 10 in., with a cross section of something like 2 by 2 in. Its density is rather under 1, or about twice that of the ordinary hand-cut sods made on the same bog. The blocks can be sawn and cut like hard wood; and they stand transport with very little breaking-up into smalls. In this respect they contrast very favourably with the ordinary hand-cut sods, which break down seriously in transport by rail or road.

The result of last year's experience at Turraun shows that:

(1) Machine peat dries more quickly than "cut peat" under equal weather conditions.
(2) Peat spread during August, and even as late as Sept. 3, will have dried sufficiently—say, to 35 p.ct. moisture—to be used as a fuel.
(3) It was possible in the wet and unfavourable season experienced to dry three separate spreadings of peat on the same area.
(4) The peat cut and spread as early as Feb. 5 was little damaged by the rain and frost in the early part of the year, and was harvested, although four months were required to complete the process.
(5) The peat winning season at Turraun extended over seven months last year—namely, from Feb. 5 to Sept. 3.
(6) Machine peat can be "footed" when containing 75 p.ct. moisture or less, and may be "clamped" when containing 40 to 50 p.ct. moisture. Slow final drying is necessary to get the best results with machine peat; and it is advisable that this should be done in a large "clamp"—the toughest blocks being thus produced.
(7) The season referred to had been one of the wettest experienced for some years. In six out of eight months the rainfall exceeded the average for the past five years; and although June was a dry month, there were 163 rainy days in the eight months.

Steam-raising trials at the Fuel Research Station have shown that the peat in this form is an excellent fuel. Though the evaporative efficiency actually obtained was only 65·4 p.ct., this was obviously due to the unsuitability of the furnace arrangements. Further trials will be made under more favourable conditions.

Peat blocks lend themselves admirably to carbonization, either in vertical retorts at temperatures between 700° and 900° C. or in steel retorts at 550° to 600° C. The charcoal resulting from

carbonization is an ideal fuel for suction-gas producers. The oils obtained by carbonization are now being examined.

As coal is likely to remain the chief source of fuel, not only for Great Britain, but for the world at large, the problems of its winning, preparation, and use still occupy the foreground in all serious consideration of the subject. In the solution of these problems there is ample scope for the skill and enterprise of an increasing number of fuel experts and engineers, not only in the pioneering work of experiment and inquiry, but in the organization and development of new methods as these are evolved.

In seeking to come to closer quarters with these questions, it may be helpful if we can set them out with some sense of proportion and perspective as they appear from the British point of view. We know, broadly, that in normal times before the war, the annual output of coal of the mines of the United Kingdom was approximately 287 million tons, of which 189 million tons were consumed as follows:

1.—Railways	15·0	million tons.
2.—Coasting steamers	2·5	,, ,,
3.—Factories	16·0	,, ,,
4.—Mines	20·5	,, ,,
5.—Iron and steel	31·0	,, ,,
6.—Other metals	1·3	,, ,,
7.—Brick-works, potteries, glass, and chemicals	5·8	,, ,,
8.—Gas-works	18·0	,, ,,
9.—Domestic	35·0	,, ,,
	189·1	million tons.

If from this total we deduct items 5, 6, and 8 [iron and steel, other metals, and gas-works]—together say 50 million tons—the balance of 139 million tons represents the amount which is burned in the raw or natural state of the coal. The greatest of the fuel problems of the future is to decide what proportion of this huge total it will pay to subject to a preliminary operation of carbonization or gasification, with the object of sorting-out the potential thermal units of the coal into groups of higher availability or greater convenience as fuels—*e.g.*, gas, motor spirit, fuel oils, and coke.

Though the operations of carbonization and gasification necessarily involve the expenditure and loss of some of the thermal units of the coal, so that the collective thermal value of the new fuels is less than that of the original coal, yet the loss may be more than compensated for by the increased value of some of the new fuels.

At the prices of to-day, a "therm" in the form of coal costs from 1d. to 2d., while in the form of motor spirit its cost is from 20d. to 25d., and in the form of town gas 10d. to 15d. These figures show the premiums which can be paid for the higher "availability" of special fuels. The general recognition of the value of availability and convenience of the more costly forms of fuel must not tempt us to overlook the necessity for a critical examination of the uses to which the more expensive fuels are being devoted.

In the case of motor spirit, there is a decided tendency to regard mere convenience as a sufficient justification for its use. While for swift transport by air and by road there is no cheaper substitute in sight, there are good grounds for believing that, for the heavier forms of traffic, motor spirit may be replaced by much less expensive fuels. A certain amount of success has already been attained in the use of small suction-gas producers in the slower and heavier classes of motor vehicles. The best hopeful prospect in this direction appears to me to be based on the designing of small suction-gas producers for definite types of solid fuel. The inventor too often feels that the success of his invention will depend on its adaptability to a great variety of conditions; and he fails to make any one successful design by attempting to deal simultaneously with a number of variables.

Small suction-gas producers for motor vehicles ought, in the first instance, to be definitely designed for, and worked with, one definite type of solid fuel. Anthracite, low-temperature coke, wood, charcoal, and peat charcoal, each have their special characteristics, which will affect the design and working of the gas-producer. The more important features which must be taken into account are: Freedom from tarry or oily impurities, density, inflammability, and the quantity and nature of the mineral ash.

Before considering in more detail the role of carbonization and gasification at various temperatures as a means of sorting out from raw coal solid, liquid, and gaseous forms of fuel, let us pass in review very broadly the uses to which the 139 million tons of coal are put which are consumed in the raw state.

We all take our share in the consumption of the 35 million tons of coal which are devoted to domestic use; and most of us have a kindly feeling for our old friend the open fire. The work of Dr. Margaret Fishenden on open fires has definitely shown that, under reasonable conditions of firing, 20 p.ct. of the total potential heat of the raw coal is radiated into the room, and that a further 20 to 30 p.ct. is given up to the fabric of the building before the waste products of combustion leave the chimney. Smoke and soot are, however, an unduly heavy price to pay for the transient cheerfulness of the flaming coals in a well-stoked fire, especially when we remember that over long periods the ordinary fire is only smouldering and dreary looking. The coal-fired kitchen range, unlike the open room fire, has few, if any, sentimental associations, and its replacement by gas-cookers and coke-fired water heaters is only a matter of time.

I have for many years taken a deep interest in the production of a solid smokeless fuel for domestic purposes by the carbonization of selected coals at 550° to 600° C. The resulting coke is entirely free from smoke-producing hydrocarbons, while still containing 10 to 12 p.ct. of volatile combustible matter, which burns with a very slightly luminous, perfectly smokeless flame. When the coke is kindled, it becomes enveloped by these flames, which quickly raise the surface to incandescence. Undoubtedly, if this smokeless solid fuel could be produced at a cost permitting of its being sold at little more than the price of the coal which it would replace, it would lead to a complete revolution in domestic heating, and, among other good things, to the abolition of black smoke from house fires. This attractive prospect has been spread before our eyes for many years by enthusiastic inventors and company promoters, yet its realization seems always to move a little further into the future.

The problem really has two distinct sides—the technical and the economic. On the economic side the data for a final solution will only be obtained after the technical solution has been reached. In other words, until a fair-sized industrial plant has been carried on continuously over a long period, making and disposing of all the products of carbonization under steady market conditions, no one can say whether or not the business will be a profitable one.

On the engineering side, an efficient and not too costly apparatus must be designed and constructed in the working of which manual labour, fuel consumption, and maintenance costs are all reduced to a minimum. In these respects—as well as in its output capacity on a given ground area—the apparatus must stand comparison with gas-retorts and oil-shale retorts of the most modern types. Only when this ideal has been practically realized can the future of low-temperature carbonization as a business proposition be put to the test of continuous working on a large scale under the labour and market conditions of the day.

From the experience of the past two years at the Fuel Research Station with a considerable variety of coals, we know with certainty the yields and quality of the gas, oils, and coke produced under definite conditions; but this knowledge is only the first step in the inquiry. For, until we know with equal certainty the cost of producing these, and the markets in which they are to be disposed of, no economic balance-sheet of any real value can be arrived at.

Let me illustrate the market uncertainty by a few comparative figures. Assume that 15 gallons of fuel oil suitable for naval use can be obtained from a ton of coal. Six months ago the value of this oil could safely be taken at 1s. per gallon; and the 15 gallons would have realized 15s. To-day, the price of this oil is only 4d. per gallon; and the product would therefore only realize 5s.—a drop of 10s. per ton on the coal carbonized. It is obvious that a method of carbonizing which would have paid its way handsomely six months ago would to-day result in a loss. My own belief is that low-temperature carbonization can only be established on a sound commercial basis with low operating costs and a very moderate margin of profit.

Prior to 1914, the shale-oil industry in Scotland was distilling three million tons of shale per annum. The entire cost of the carbonizing operation, for labour, maintenance, and fuel was 1s. 6d. per ton; and the margin of profit on which fair dividends were paid was 2s. 6d. per ton. Unless the costs and profit margins of low-temperature carbonization can be reduced to the modern equivalents of these figures, the prospects of its development on a great scale are not hopeful, from the national point of view.

If low-temperature carbonization is proved to be a feasible operation commercially, it would find its first and most natural application to the 35 million tons of coal used for domestic purposes. Were this coal all carbonized, it would produce about 2 million tons of fuel oil for the Navy, or considerably more than the peace requirements, though very much less than the war requirements. The motor spirit produced would amount to about 100 million gallons.

The capital expenditure required for the installation of carbonizing plant for 35 million tons of coal per annum would be of the order of 30 to 40 millions sterling. A gross profit of 5s. per ton of coal carbonized would provide 10 p.ct. for interest and 10 p.ct. for depreciation on this expenditure.

The application of low-temperature carbonization to raw coal which is used in the industries must necessarily depend on the successful solution of the technical and engineering problems to which reference has been made. In this case also the future possibilities of this application depend entirely on the evolution of apparatus and methods which will reduce the capital and working charges of the operation to a minimum.

When coal is used for steam-raising under the best-known conditions, it is obvious that there is little to be gained in thermal efficiency by any preliminary sorting-out of the thermal units of the coal into fuels of higher availability. It is well known that an efficiency of 75 to 80 p.ct. is attainable in steady practice. This is brought out by the results of the working during the first quarter of the present year at the two London power stations to which reference has already been made. At the station of the General Electric Supply Company the average efficiency, less banking, was 75·5 p.ct., though the average percentage of ash was 18·4. At the Durnford Road power house the average efficiency was 78 p.ct., and the average percentage of ash was 16. Supposing the coal used at these stations had been submitted to preliminary carbonization and its thermal units sorted-out into the

forms of gas, tar, and coke, how would this have affected the evaporative efficiency of the total thermal units of the coal?

The coke would contain		70 p.ct.
,, gas ,, ,,		12 ,,
,, oils ,, ,,		11 ,,
		93 p.ct.
Intrinsic thermal loss	7 p.ct.	
Heat to be supplied for carbonization	6 ,,	—13 ,,
Net thermal value of the products		80 p.ct.

The high thermal availability of the rich gas would be thrown away if it were used for steam-raising; the fuel oil would be a boiler fuel decidedly superior to the original coal; and the coke would not be of more than equal value to the coal. Solely from the steam-raising point of view, therefore, a thermal loss would result, and not a gain, from the operation.

I at once admit that in special cases this thermal loss might be compensated for if a local market for the rich gas were available. In most cases, however, the margin of profit would be much too small to justify the extra capital expenditure required.

The valuable papers of Mr. D. Brownlie* throw a much-needed light upon the use of coal for steam-raising. His analysis of the statistics which he has collected shows that the amount of coal used for steam generation in this country for heat and power production is from 75 to 100 million tons per annum, or about one-half of the whole coal consumption. Mr. Brownlie's conclusions as to the comparative efficiency of the numerous boiler plants he has personally examined during the past seven or eight years, and the extension of these conclusions to cover the whole steam-raising practice of the United Kingdom, supply us with material on which some broad generalizations may be based. Mr. Brownlie divides the existing boiler installations in the United Kingdom into three classes—bad, average, and highly efficient. Of the total number, 10 p.ct. are bad, 85 p.ct. are average, and 5 p.ct. are highly efficient. As regards the efficiencies of each class, with water-tube boilers, the bad give 61 p.ct., the average give 69 p.ct., and the highly efficient give 82 p.ct.; while with Lancashire boilers, the bad give 49 p.ct., the average give 60 p.ct., and the highly efficient give 79 p.ct.

If we take the minimum figure of 75 million tons as the amount of coal annually used for steam raising, it is clear that the scope for economy is enormous; for even a moderate increase of efficiency of 10 p.ct. over all would result in a saving of 7½ million tons per annum. Mr. Brownlie's own experience of the savings to be effected by the reorganization of existing plants leads him to take a much higher saving as a possibility. In the case of the colliery steam-boiler plants (the average efficiency of which he places at 51 p.ct.), he estimates that the coal bill for all the colliery plants in the country is 18½ million tons, and that the efficiency might easily be raised by 10 to 15 p.ct.; while by the systematic use of colliery waste a further saving of saleable coal would be realized.

Mr. Brownlie's facts and figures are well worth the careful study of all who are seriously interested in fuel economy. These show the enormous possibilities in this direction which are actually within our grasp if we will only avail ourselves of the knowledge which already exists. No new and revolutionary discoveries are required for their realization. The problem of the future which awaits solution is how to stimulate the practical interest of the owners of steam-raising plant throughout the country. It may be that the permanently increased cost of coal will supply the necessary stimulus; but this will only begin to take effect when the industry has settled down to more normal conditions. For steam-raising in this country, the cheapest form of fuel is coal or coke, if it is used under reasonably scientific conditions; and so long as this is the case, the use of fuels of higher availability will only be economically practicable under very special conditions.

In America the use of pulverized fuel is making steady progress, not only for metallurgical purposes (for some of which it is very suitable), but even for steam-raising. The case for steam-raising by this method is still, however, by no means clear.

The primary object of the coke industry is the production of hard coke for the manufacture of iron and steel. The coals must be of a special type. The therms obtained in the form of gas, though of high availability, are primarily used for the heating of the coke-ovens, for which therms of lower availability would do equally well. In a few instances in this country the surplus gas is sold to gas undertakings in the neighbourhood of the coke-ovens; and in these cases full advantage is taken of its high availability. In Northumberland and Durham the surplus gas from the coke-ovens is used for the generation of electricity by steam-boilers and engines; the current produced being fed into the main circuit of the Newcastle Power Company. In this case the high availability of the gas therms is thrown away in doing work which could be done equally well by cheaper therms in the form of coal or coke. The tar and ammonia which are recovered from the coke-ovens take their place side by side with the same products of carbonization in gas-works. The hard coke, owing to its density and the practical absence of volatile matter, is quite unsuitable as a domestic fuel, except in specially constructed stoves or water-heaters.

The future development of the coking industry must mainly be determined by its intimate association with the iron and steel industry.

* "Engineering," July 12 and 19, 1918; July 25 and Aug. 1, 1919; Dec. 10 and 17, 1920.

In the gas industry, the fuel problems of the future have a new interest since the publication of the report of the Fuel Research Board on the results of their inquiry into the subject of gas standards. As you are no doubt aware, the results of this inquiry led to the adoption by the Board of Trade of a new method of charging the consumer for the gas which passes through his meter. The volume of this gas is still measured and recorded; but the consumer no longer pays on thousands of cubic feet, but on the product of the multiplication of the number of cubic feet passed by the standard calorific value of the gas per cubic foot. The unit of charge is the "therm," which is the name adopted for 100,000 British thermal units. Under this system it is now possible to give gas undertakings a wide latitude in the selection of the standard of calorific value which they adopt, and therefore a much wider choice of the methods by which the gas is manufactured. In the report it was stated that the great gain for the gas undertakings under the new system would be that no undue legislative restrictions would limit them in their development of the most economical production of thermal units in the form of gas. It was pointed out that there was still great scope for this development, as, according to present practice, only from 21 to 24 p.ct. of the total potential thermal units of the coal is being sold in the form of gas.

To increase this percentage, two methods were available, both depending on the production of water gas by one or other of the reactions between steam and carbon at a high temperature. The first of these methods was the old-established one in which a portion of the coke produced in the retorts was transferred to a separate producer, in which it was raised to bright incandescence by an air-blast and then subjected to the action of a current of steam. The thermal efficiency of this operation ranged from 45 to 55 p.ct., according to the method of blowing-up and steaming adopted. The second method has recently been chosen in connection with vertical retorts. In this case the water-gas reactions are carried out in the lower part of the column of red-hot coke in the retort itself, by passing through it a current of steam. The volume of gas produced is much increased, though its calorific value is reduced by the addition of water gas to the hydrocarbon gas resulting from the carbonization of the coal.

It was foreseen by the Fuel Research Board that the introduction of the new thermal standard would open the way to a more general adoption of this method; and a setting of vertical retorts was installed at the Fuel Research Station with the object of obtaining trustworthy data as to the conditions and the limitations of the steaming process. A full report on the results of the experimental working during the past year was recently presented to the Institution of Gas Engineers.

As the experimental plant at the Fuel Research Station is especially adapted for the obtaining of full and accurate thermal and other data, it is now possible to speak with considerable confidence on the economic bearings of this process as applied to several distinct types of coal. Two of the questions which it was proposed to answer were:

(1) Under pre-arranged conditions of temperature and percentage of steam, how will the yields of the principal products —gas, tar, coke, and ammonia—be affected in different types of coal?

(2) To secure the increased yields of products, how much extra heat must be supplied to the retorts?

The gain which is of most importance to the gas industry is that of "therms" in the form of saleable gas. It had been common knowledge for some years that this gain by steaming was an assured one, if gas of a calorific value of 400 to 450 B.Th.U. could be established as a saleable commodity. It was not equally certain what the effect of steaming would be on the other products —tar, coke, and ammonia.

We can now say with confidence that there is not only a very substantial gain in therms in the form of gas, but also in the yields of tar and ammonia. I will only quote the results of one set of tests, which were carried out on a South Yorkshire coal of good quality.

At a working temperature of 1260° C. and with 21 p.ct. of steam, the gains per ton of coal were:

22 therms in the form of gas,
34 lbs. of tar, and
6 lbs. of ammonium sulphate.

While without steam, only 23 p.ct. of the potential heat of the coal was obtained in the form of gas; with steam, 33 p.ct. was obtained. The extra heat which had to be supplied to the retorts in order to produce these results was ten therms per ton of coal carbonized. It is estimated that the additional value of the products obtained by steaming amount to at least 10s. per ton of coal carbonized.

The general adoption of steaming in vertical retorts will almost certainly be followed by a great extension of the use of this form of retort, and a very substantial saving will result, both as regards gas undertakings and consumers at large.

Conclusions.

From this brief review it appears that coal is likely to remain for a long time the world's chief source of fuel. Its more efficient use may be secured:

1.—By more careful sorting and preparation at the mines.
2.—By the improvement of boiler firing on well-known lines.

3.—By the sorting-out of its combustible constituents into fuels of higher availability or convenience by preliminary carbonization carried out either at high or at low temperatures. This has an important bearing on the development of home sources of fuel oil and motor spirit and on the production of smokeless solid fuel for domestic purposes.

The development of oil shales as a source of liquid fuels is still only in its initial stages; but it has evidently a great future.

The problems of the utilization of peat, which cover a wide range, both technically and economically, are mainly of local importance, and are not likely to affect the fuel supplies of the world to any great extent.

The production of alcohol on a really large scale as a motor fuel of high availability bristles with economic and technical difficulties; and it is still too soon to pronounce an opinion on the possibilities of the future.

Most, if not all, of these problems on their technical side are probably capable of solution by the skill and application of the industrial pioneers of the world; but the most difficult of the fuel problems of the future are those into which the human element enters so largely. At home, the relations of the wage-earning classes with the actual leaders who initiate and direct our industrial policy, and abroad, our relations with other nations who are equally interested with ourselves in the natural resources of the world, are profoundly affected by the spirit of the times. This spirit, as it is manifesting itself to-day, is fatal to the progress of reconstruction and development on any extensive scale; and we, whose chief interest in life lies in the control and use of the powers and resources of Nature for the service of man, can only continue to do the work next our hand while we cherish the hope that the better side of human nature, which we know is only temporarily overshadowed, will gradually reassert itself.

WOOD CARBONIZATION AT STEYNING.

According to an interview which has been published in the newspaper Press, Mr. E. J. Fottrell, the Joint Manager of the National Gas Council, stated that the most successful use of wood gas yet reported to the Council has been by the Steyning (Sussex) Gas Company. "What Steyning is doing," added Mr. Fottrell, "other small gas companies could do, providing they are favourably placed for wood supplies." In view of this we have obtained Mr. Fottrell's sanction to the publication of the following statement upon the matter, which appeared in the Council's May report.

REPORT FROM STEYNING.

The Steyning Gas-Works supply a population of about two thousand; and their annual make is about 7 million c.ft., most of which is used for cooking and heating purposes. It was owing to running out of coal that the writer attempted the experiment of keeping the limited supply going with wood.

We were offered imported coal at 76s. 6d. per ton on board ship, which would thus cost at least £5 by the time it was in the works. In order to ascertain the value of this coal, the writer has had two trucks in; and he finds that not more than 10,000 c.ft. can be got out of it per ton, but it gives a good coke. If this coal were used, we should make a loss of at least £30 per week, which would mean the closing of the works. Consequently wood has been resorted to. Being a small works, the means of testing the calorific value of the gas are not available; but comparisons with our ordinary coal gas are given.

The whole of the wood used is oak, cut about six months ago, which was grown about half-a-mile from the works. The writer has bought 76 cord of this wood at 26s. per cord delivered to the works. It is all cut in 4-foot lengths, and is in pieces from 6 in. to 9 in. in diameter. The larger pieces are split once before being put into the retorts.

Two beds of four retorts each are being worked at present, direct fired; and these eight retorts hold half-a-cord of wood. Great care has been taken in averaging, as accurately as possible, the amount of gas, &c., produced from a cord; and it is found that the following is the average amount: 6000 c.ft. of gas, 4 cwt. of charcoal, 13 gallons of tar, and a quantity of liquor. The writer cannot fix the heat of the retorts; but it is the same as is used for producing the coal gas—the better the heat the better the quantity of gas.

As the wood is totally carbonized in four hours, and there is more labour in drawing and charging the wood, it is found we cannot get more than five charges in the 24 hours—that is to say, not more than 15,000 c.ft. can be produced in 24 hours. As the consumption is at present 125,000 c.ft. per week, one day each week we carbonize coal to make up the difference. It is found that to charge some of the retorts with wood and some with coal is not satisfactory, as thereby the make of gas from the wood is reduced by 50 p.ct. When coal is being used, the whole of the tar and liquor in the hydraulic is emptied out and kept entirely separate from the coal tar.

The light is maintained the same as with wood; no difference being perceptible in the light in the town or the heating capacity of the gas. Working with coal, a 5-in. flame is maintained on the photometer, and with wood a 4-in. flame. The writer finds, by the results in the town, that the two are equivalent.

The greatest difficulty experienced is in keeping the exhausters cool. The gas is passed through a scrubber and oxide purifiers; and the purifiers do not require renewing as often as with coal.

ANALYSIS OF TAR AND LIQUOR FROM THE STEYNING GAS-WORKS.

The following is a report of an analysis of samples of the tar and liquor forwarded to the Council.

The sample of liquor has a specific gravity of 1·020, and contains 1·2 oz. free ammonia and 3·2 oz. fixed ammonia. Small quantities of acetic acid (as ammonium acetate) and acetone are present, and traces of methyl alcohol. The composition of the sample points to a mixture of ordinary gas liquor and the watery distillate obtained on distillation of wood; the ammonia coming from the coal, and the acetic acid, acetone, and methyl alcohol from the wood. The only constituent of any value is the ammonia; and as this is so weak, I am doubtful whether any ammonia distiller would accept it. The aqueous distillate from wood is usually worked up for the production of acetate of lime or acetic acid, methyl alcohol, and acetone; but the manufacture of these is only profitable where large quantities are available, where the material can be conveyed by pipe line, or at low transport charges.

The sample of tar shows:

Specific gravity	1·103	
Water	22 p.ct.	
Free carbon (dry)	7·14 ,,	
Light oil	8 ,,	(sp. gr. ·932)
Creosote oils, &c.	23·1 ,,	
Pitch	46·9 ,,	

The creosote has a specific gravity of 1·035 (tar acids 13 p.ct.) and shows on distillation (retort):

	°C.
Start	155
10 p.ct.	200
20 ,,	240
40 ,,	295
60 ,,	320
80 ,,	348
All off	360

The composition of the tar shows it to be a mixture of coal-gas tar and wood tar; and the characteristic smell of wood tar is strongly in evidence. The tar acids contain practically no phenol, but consist mainly of cresylic acid, guiacol, and other high-boiling acids found in wood tar. The tar has no special value, and could be disposed of to tar distillers in the ordinary way; but it would be advisable to reduce the water content.

Wood is also being used by the Birmingham Corporation for gas making. Air-dried wood, which was obtained by the Government during the war for the manufacture of charcoal, is the raw material; and it is said to yield a gas of inferior quality. This is mixed with other gas in a small proportion, and goes to swell the total volume available for consumption. Experiments are contemplated for converting into gas old wood pavement blocks.

Scale Removal and Pipe Corrosion.

Wrought iron was universally used for welded pipe prior to 1888; but a more uniform and economical material for pipe manufacture was demanded, which led to experiments in the use of Bessemer steel for the purpose. Subsequently the use of steel pipe steadily increased, and now forms over 90 p.ct. of the entire production of wrought pipe. Most of the scale on the outside of the pipe, said Mr. R. B. Verdery, of Atlanta, in a paper submitted at the Southern Gas Association convention, is removed during manufacture in the sizing and straightening rolls; but inside the pipe the scale is often one-thirty-second or one-sixteenth of an inch thick in patches, and when cold is firmly attached to the metal like an enamel. Several means have been used to remove this scale to prepare the pipe for galvanizing and other coating operations. By making the diameter of the pipe larger, and then reducing the size and elongating the pipe at the highest temperature at which the scale is brittle enough to remove, it has been found possible to clean the pipe in the process of hot-finishing, and at the same time to produce a better material in other respects. This new process consists of two additional steps other than regular methods: (1) A partial cooling of the pipe from 2500° to 1800° Fahr.; and (2) a reduction in diameter and elongation of about 10 p.ct. in length by means of a series of horizontal and vertical rolls, by which the brittle scale is cracked and separated from the steel. The pipe is then straightened and cooled as usual, during which a thin film of new oxide forms sufficient to protect the metal from rusting while being handled. A thin coating of suitable lacquer is next applied, which affords substantial protection to the pipe in storage. The main object of these scale-removing and cleaning operations is to make possible more uniform galvanizing. The scale-free surface rusts much more uniformly than when covered with heavy mill scale, which results in the pitting of the metal. For this reason, it is usually of advantage to have the scale removed, especially where the pipe is buried in the ground or subject to other active corrosive influences.

An announcement has been made to the Académie des Sciences by Baron Edmond de Rothschild of his intention to devote the sum of 10 million francs to the foundation of a laboratory of scientific research, to be chiefly devoted to the development of physical and chemical science.

FIFTH REPORT OF THE RESEARCH SUB-COMMITTEE OF THE GAS INVESTIGATION COMMITTEE OF THE INSTITUTION OF GAS ENGINEERS.

THE SIMMANCE RECORDING CALORIMETER.

(*Continued from p.* 684.)

DETECTION AND INFLUENCE OF LEAKS IN GAS SYSTEM.

For an accurate determination of C.V., it is essential that all gas passing through the meter should reach the burner-head; and a test of this point is required, for example, by the Referees' "Notification" when using the Boys calorimeter. If this is important when using gas at 5 c.ft. per hour, it becomes more important still with the Simmance calorimeter, which only burns 2 c.ft. per hour approximately. The chief difficulty in testing for leaks is due to the ease with which the oil-seal of the governor can be "blown" if the apparatus is put under pressure. A method of testing for leaks which has proved satisfactory in our hands is described in Appendix I. (12). All leaks must, of course, be remedied before testing can take place. If leaks should exist, they will cause no difference whatsoever between the observed and charted C.V., and, if small, may thus be overlooked. The observed C.V. will, however, be consistently low; and in the absence of other evidence this may be ascribed, quite wrongly, to imperfect combustion, or imperfect heat absorption in the calorimeter.

WATER SYSTEM.

The water system of the calorimeter will now be dealt with. Our description and criticisms apply to the calorimeter as originally supplied to us for testing. In later instruments, some very valuable improvements have been introduced (see Appendix II.); but inasmuch as the investigation of the older type brought out a number of important points in connection with flow-calorimetry in general, this part of the report is presented in its original form.

COURSE OF WATER THROUGH THE APPARATUS.

[A photograph of the calorimeter and two detail drawings, of which fig. 2 is reproduced below for the convenience of readers, appeared in last week's "JOURNAL."]

Water enters the apparatus through a ¼-in. brass tube, and after passing through the gas-cooler reaches the top of the air saturating column A, where it discharges into a cylindrical vessel B, about 4½ in. diameter. Here the bulk of the air mechanically carried by the water is liberated. A depth of about ¾ in. of water is maintained in this vessel; the excess flowing by the pipe C, from the end of which there should be a continuous trickle to the waste tank. This pipe is brought well down into the waste tank; and it is not easy to see whether water is flowing or not. A more

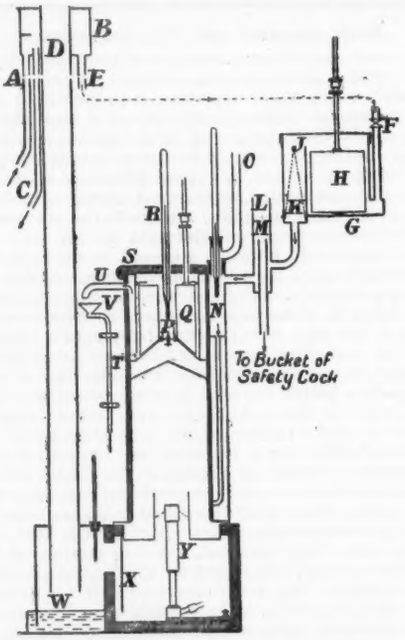


Fig. 2.—The Simmance Continuous Calorimeter.

easily visible overflow could be readily designed. A small proportion of the water flows through perforations at D, and serves to maintain a continuous film of water on the inner surface of the air saturator column. The supply of water leaves by the ¼-in. pipe E; its quantity being regulated by the cock F, so as to maintain an overflow at the weir M. The water enters a cylindrical vessel G near the bottom, and, after passing over the cold bulb of the differential air thermometer H, overflows at the top on the side remote from the inlet—*i.e.*, at J.

As the vessel G is provided with a loosely-fitting lid, there is a second opportunity of liberating mechanically carried air at this point. From G the water flows on to a conical wire-gauze filter. After one or two accidental floods owing to this filter making-up when the water had been dirty for short periods, it is suggested that a suitable overflow pipe should be run from the upper side of the filter to the waste tank, in order to meet this contingency. From K, the water again rises to an open head in the tube L, giving a further opportunity of liberating entangled air (which, on occasion, has been found to be drawn in when passing the filter, thus partially neutralizing the work of the two open heads previously encountered). The tube L contains an inner tube M, consisting of an inner and outer sleeve screwed together. The cock F is set to maintain a continuous overflow down the pipe M; this water being directed into the bucket controlling the safety cock.

The rate of water flow is put entirely out of the control of the operator; being determined by the height of the overflow weir M, as adjusted by the makers. From the annular space between L and M, the water passes by a short horizontal connection to the chamber carrying the inlet mercury thermometer at N. In the instrument as originally supplied to us, this chamber was surmounted by a glass tube in which the inlet thermometer was loosely suspended, thus providing a fourth and final outlet for air mechanically carried by the inlet water. For reasons to be detailed later, it was desired to have an unobstructed view of the thermometer-stem; and as this seemed a vital point for an air release, this device was retained by providing a short glass T-piece with a cranked limb, as shown at O. From the inlet chamber N, water passes by a ¼-in. pipe to the base of the calorimeter; being protected from draughts and greatly strengthened by a wider outer tube. The interior of the calorimeter is not accessible for examination; but we are informed that the water enters a shallow ring at the base of the calorimeter, from which it emerges on the opposite side from the inlet, and is guided to the top of the calorimeter by a spiral ribbon in the water space of the instrument. This converts the instrument into one of the "series flow" type; and the water space is so limited that irregularities due to convection streams in the water, and consequently variations in outlet water temperature, are perfectly eliminated.

At the top of the calorimeter, the water enters a spiral passage in a massive casting, and eventually emerges at a central hole P, 7·64 in. in diameter. The top of the casting is screwed, and on to it is fastened the outlet-bulb of the differential air thermometer Q. The water passes up the central passage of the air thermometer bulb, and over the bulb of the outlet mercury thermometer, once more coming to an open head under the loosely-fitting wooden cover S, for the liberation of air. The water does not at once pass to the outlet, but is taken off by an opening T, at the lowest point of the chamber carrying the outlet-bulb of the air thermometer. From T the water passes upward to the outlet-spout U, the end of which next the calorimeter is partially obstructed by a diaphragm. By broaching out this diaphragm, the water-rate is roughly set to a suitable value, and subsequently the adjustment is completed by raising or lowering the weir M, upon its screwed sleeve. The available head between M and U, determining the flow of water, is roughly 3 in. From U, the water passes to a measuring vessel placed immediately below, or alternatively to the waste tank by the deflecting funnel V. As at present constructed, there is an undesirable amount of splash when running water into the measuring cylinder; and it is clearly necessary to make provision for bringing the cylinder nearer to the overflow spout. The various overflows discharge into a small tank below the meter; and the makers point out the advisability of providing this tank with a sufficiently large outlet to a neighbouring sink, if annoyance due to occasional floods is to be avoided. A ½-in. iron pipe is recommended.

RATE OF WATER FLOW.

For an accurate record of the C.V. of a gas, it is essential that the water flow through the instrument should be constant. The highest and lowest rates of water flow with our instruments during six months have been 350 and 257 c.c. per minute respectively, though the water passages have been cleaned several times in the interim. This shows a wide variation, and indicates the need for investigation. In fairness to the instrument, it may be pointed out that, when observed over lengthy periods, and in similar circumstances, the Boys and Junkers calorimeters and the R. H. Smith radiometer, all of which employ constant head devices, fail to some extent in the same way. These instruments, however, are used for intermittent testing; and the change taking place during a single test is usually so small as to be negligible. It is anything but negligible in the case of a continuous recorder. Where the changes in water rate are small—say, not exceeding 1 or 2 p.ct.—a sufficiently accurate adjustment can be made by merely correcting the position of the pen on the chart. Where, as in the present case, the variation is greater than this, the charted C.V. will be inversely as the water rate for which the chart was initially adjusted; and, in these circumstances, either

the original water-rate must be restored or the leverage of the pen movement altered to suit the changed water-rate.

Irregularities of water flow are dependent to a marked extent upon the character of the water supply, and generalization is difficult. The makers themselves have found it necessary to redesign the water system to deal effectively with waters encountered in different parts of the country [see Appendix II.]. At the outset, it was not thought feasible by the Research Sub-Committee to imitate various water supplies with precision, and on a scale likely to furnish information of value as to their influence upon calorimeters in continuous use. Information upon this point can be most usefully obtained by exchanging the experiences of users in different parts of the country. Corrosive waters would naturally reduce the life of the calorimeters; but the most objectionable, as producing irregularities in working, would seem to be those capable of forming obstruction or scale of one kind or another. Three main types of water supply are considered in Appendix I. (13). The water supply at the testing laboratory was not of constant character. At times a treated well water, perfectly clear, but with a total hardness of 18°, was supplied. At others, a moorland water of only 3° hardness was supplied; but this gave exceptional trouble, on account of organic deposits in the calorimeter, especially in the summer months [see Appendix I. (13) iii.]. It must not be taken from these statements that circumstances compelled us to use an exceptionally difficult water. As a matter of fact, it was the public water supply of a large city (Birmingham), which is excellent for most domestic and industrial purposes. The trouble is due to the ease with which the passages in the Simmance calorimeter become obstructed, and to the difficulty in cleaning them effectively.

Difficulties in Dealing with Water Flow.

On account of the numerous open heads, no really effective pressure can be exerted to send a good flush of water through the calorimeter. The method most successful in our hands has been to connect a high-pressure water supply to the opening of the casting at P (fig. 2), and send as vigorous a current of water as the small hole would permit in the opposite direction to that normally taken by the water. If so small a hole is necessary at P for control of the water, it might be possible to make this in a diaphragm, removable during the flushing operation. Even with this treatment, it has not proved possible to restore the original rate of 350 c.c. per minute; the best obtainable after recent cleaning now being 315 c.c. per minute (March, 1921), or a permanent drop of 10 p.ct. in the water rate. The water rate seems to fall most rapidly after the calorimeter is freshly cleaned, and with the water in use does not appear to settle down to a steady decrease for some 24 hours or more; being apparently more regular after the initial coating of slime has reformed. The rate at which the water flow falls off must vary considerably with circumstances; and an approximate value only can be given. This rate would appear to be between 0·5 and 1 p.ct. per day of 24 hours with the Birmingham water supply, so that the accumulated difference in a week's working may be considerable if the calorimeter is run continuously without attention. Some proposals for dealing with the calorimeter water supply are criticized in Appendix I. (14).

It has been suggested in certain quarters that irregularities in the water flow may be due to air-locking in the calorimeter. The provision for freeing the inlet water from entangled air is elaborate, almost too elaborate; but there is no doubt that it is effective. The calorimeter in use has been run on its ordinary water supply for 60 hours continuously; the burner being extinguished, without collecting more than 0·5 c.c. of air from a tube inverted over the opening P, notwithstanding the fact that the inlet water was several times churned up with air before reaching the calorimeter.

It is, however, necessary to consider the gas liberated by warming the water, which can find no outlet until it reaches the opening P. The last portion of the path traversed by the water is through a spiral channel cast in a brass block; and it is conceivable that small bubbles of liberated gas might collect here until of sufficient size to be bodily detached. Much will depend upon the finish of these passages in individual instruments; and while not denying the possibility of air-locking, it has not been our experience with the instrument submitted for examination, and the designers seem to have been to some pains to eliminate possible trouble in this direction. Thus, with a difference of 10° C. between inlet and outlet temperature, there was a liberation of gas amounting to 17 c.c. in 20 hours. This came off as a stream of fine bubbles for the most part, but occasionally in bubbles as large as 0·5 c.c. No appreciable alteration in the water rate was noticeable before and immediately after the discharge of one of these larger bubbles. In the case of this particular instrument, irregularities due to air-locking have not been found.

Viscosity of Water.—In addition to the above irregular disturbances, there are others of a systematic character. Thus it was noted at a very early stage that the water rate determined with the cold calorimeter failed to agree with the result obtained when the burner was lighted. This may be attributed to two causes: (1) The well-known rapid decrease in the viscosity of water when its temperature is raised. (2) The fact that the constant head at the inlet is subjected to the back-pressure of a column of the same length, but of reduced density, when opposed by warm instead of cold water. The former is the more important; and the following tests were made to elucidate these points. In the first place, a suitable heater was placed in the path of the incoming water, and the water rate noted at successive increasing temperatures. The burner was extinguished during the test, so that we are considering the passage of water of substantially the same temperature in all parts of the apparatus. The results are indicated in Table VIII., and may be taken to represent the effects of the changing temperature of inlet water at different times of the day or different seasons of the year. The rate at 15·5° C. (60° Fahr.) has been taken as a standard; but the choice is quite arbitrary. The results obtained may differ slightly with individual instruments; but for such temperatures as would be reasonable for inlet-water temperatures—say, 12° to 20° C.—the average change in water rate is approximately 0·7 p.ct. per ° C. change in inlet-water temperature. This is by no means negligible; and the necessity for a uniform inlet-water temperature should be self-evident.

Table VIII.—*Showing Variation in Water-Rate through a Simmance Calorimeter when Water at the Inlet Temperature is Passed through the Calorimeter without being further Heated (Direct Experiment).*

Inlet Temperature, °C.	Rate.	Inlet Temperature, °C.	Rate.
10	95·7	20	103·1
12	97·4	22	104·4
14	98·9	24	105·6
16	100·3	26	106·8
18	101·7	28	107·9

Rate at 60° Fahr. (15·5° C.) equals 100.

Difficulties due to changing density and viscosity of water are not entirely overcome when a water supply at constant temperature is available; but the rate will vary to some extent with the difference between inlet and outlet temperatures. In the absence of definite knowledge of the temperature distribution, it is impossible to determine a mean temperature (the arithmetic mean of inlet and outlet temperatures will not necessarily do for this purpose) in the calorimeter; otherwise the changes might be deduced from the table given above. Direct observation was therefore employed; water at a steady temperature being supplied to the calorimeter inlet, and the various temperature differences being obtained by temporary alteration of the loading of the governor. The results are given as a percentage of the initial water rate, without heating. A somewhat low value was chosen here to give a fair range of temperature conditions, without exceeding 32° C., the upper limit of the outlet thermometer.

Table IX.—*Showing Effect on Water Rate of Working with Various Differences between Inlet and Outlet Temperatures, with a Steady Inlet Temperature of 10·5° C. (Direct Experimental Determination).*

Difference between Inlet and Outlet Temperature ° C.	Water Rate.	Difference between Inlet and Outlet Temperature ° C.	Water Rate.
0	100·0	12	103·8
2	100·6	14	104·4
4	101·3	16	105·1
6	101·9	18	105·7
8	102·5	20	106·3
10	103·2		

The average change in the water rate according to the above table is 0·3 p.ct. per ° C. change in the difference between inlet and outlet thermometers (0·18 p.ct. per ° Fahr.). As at present sent out, the calorimeter shows approximately 50 B.Th.U. per ° C. difference between inlet and outlet temperatures. It is therefore advisable that the chart should be adjusted on a gas of C.V. closely approaching the mean chart value; and those values which are (say) 50 B.Th.U. either side of the mean will be in error by 0·3 p.ct., on account of the altered water rate—the error being in such a direction as to reduce the apparent amplitude of the variation in gas quality. This may be partially allowed for in setting the leverage of the pen motion.

It is important to note that the difficulties with the water supply, so far described, will appear solely as differences between the observed and charted C.V., and do not impair the accuracy of the observations made with the non-recording portion of the instrument. More serious difficulties may be experienced in obtaining a water supply with suitable temperature characteristics; but this matter is fully discussed under the head of temperature determinations.

Measurement of Water.

The water is measured in a graduated cylinder some 3¼ in. in diameter. When calibrated, this cylinder was found to be marked to show true c.c. correct at 15° C.—*i.e.*, on the basis of the normal litre. The cylinder is well finished, and every 10 c.c. is marked, the divisions being approximately 1·5 mm. apart. With care, the position of the meniscus can be determined within half a division, or 5 c.c.; this being equivalent to 0·5 p.ct. on the quantity of water usually collected during a test. This is comparable with the precision of the gas and temperature measurements, and suffices for routine work. A narrower cylinder, with an enlargement at its

lower end, as used with the Boys calorimeter, or a measuring flask with graduated neck, is preferable for more exact work.

The questions as to changes in density and specific heat of water with temperature; of weighing *versus* measuring the warm outlet water; of reduction of weighings to vacuum standard, will rarely call for corrections greater than 0·5 p.ct. with the conditions under which this calorimeter should be worked. A table is given in Appendix I. (15) to facilitate corrections, should they be required in more exact work.

Air Supply to Calorimeter.

Air enters the calorimeter by the long vertical pipe D (fig. 2), about 4 ft. long and 2 in. diameter. Water enters holes near the top, and forms a continuous film on the inner surface of the pipe; the excess water running out of a water lute in the waste tank at W. The air now saturated with water vapour enters the burner-box at the back, and flows round the baffle-plate X, and over the surface of the burner. It then passes over a perforated plate Y, in the base of the calorimeter; this serving to break-up the air stream, and also to centralize the burner in the combustion chamber. This is the only means of ingress for the air; the burner-box being, for all practical purposes, air-tight.

Products of Combustion.

The products of combustion, mixed with excess air, pass to the top of the combustion chamber and through rectangular ports into an annular space parallel with the walls of the combustion chamber; being separated from the latter by a water space. Here the gases are thoroughly cooled, the heat transmission being assisted by coils of wire soldered to the water jacket, and projecting into the path of the products of combustion, which pass downwards and emerge through two circular openings about 1 in. diameter near the bottom of the calorimeter. There are no dampers for controlling the flow of air through the apparatus.

Thermal Balances of Gas, Air, and Products of Combustion.

It is clear that in determining the C.V. of a gas we are concerned solely with the heat produced by its combustion, and any other thermal gains or losses to the calorimeter must be eliminated or allowed for by the application of suitable corrections. The most important of these errors is due to differences in the amount of sensible heat carried by the incoming gas and air and the outgoing products of combustion, and the latent heat of condensation or evaporation of water vapour associated with them.

Thus, assuming that the gas, air, and products of combustion are all at one temperature, but, as is usual in this country, that the incoming air is only partially saturated with water vapour, while the outgoing products must of necessity be fully saturated, there will be a loss of heat to the calorimeter represented by the latent heat of vaporization of the amount of water vapour carried out in excess of that carried in. The C.V. will in consequence be somewhat low. It is also possible, by the use of very cold inlet water, to obtain a C.V. which is too high. Where direct determination of C.V. is in progress, correction can be applied for this source of error as indicated in Appendix I. (16); but this is clearly not applicable in the case of the charted C.V. In the Simmance total-heat calorimeter the incoming air is cooled and saturated with water vapour at the inlet-water temperature, and in consequence it is not necessary to know or to apply corrections for the variable humidity of the atmosphere.

Upon theoretical grounds, the gross or "total heat" determined directly in this way should be very slightly higher than the gross C.V. determined by the Boys and Junkers calorimeters, even after the latter are properly corrected for humidity. The difference between the corrected results of the latter and the direct result of the Simmance calorimeter, however, will not exceed 2 B.Th.U. in normal practice, and may be neglected. The point is discussed in Appendix I. (17), and might become of importance if applied to some American conditions of working. For ordinary working conditions, this air-saturating column performs very useful functions; and a strong case can be made for its adoption.

A few points will now be dealt with showing to what extent the air saturator fulfils its intended mode of action in different circumstances.

Volume of Air Entering Calorimeter.

This varies to some extent with the difference in temperature between the air in the saturator column and that of the room, and also with the C.V. of the gas being burned. For a gas of 500 B.Th.U. gross per c.ft., burning at 2 c.ft. hour, from 13 to 16 c.ft. of air pass through the calorimeter per c.ft. of gas burned, yielding 12 to 15 c.ft. of products of combustion.

This quantity of air is about twice the amount passed through the Boys calorimeter, and more than passes through the Junkers calorimeter, unless the damper is open fully. Roughly speaking, the quantity of air is three times the quantity necessary for the combustion of the gas. With the air saturator in use, no error need be introduced greater than that indicated in Appendix I. (17) on account of this large excess of air. Moreover, this excess may be necessary for the satisfactory working of the gravity governor with a lighted burner, in order that the true products of combustion of the gas shall influence as little as possible the density of the total products of combustion, including with these the excess air. The products of combustion contain only 3 p.ct. CO_2.

Influence of Temperature of Inlet Water.

The water serving to saturate the incoming air flows in a continuous film down the inner surface of the saturating tower. Where there is a difference between the room temperature and inlet-water temperature, the temperature of the water film near the base of the tower, and consequently that of saturation of the air, may be distinctly different from the inlet-water temperature, owing to conduction of heat through the walls of the tower. It is desirable, therefore, that the inlet-water temperature should not be greatly different from that of the room; otherwise the humidities of the air and products of combustion will be disturbed, and the relations already discussed no longer hold good. The change in temperature of the water film between the top and bottom of the tower will depend upon the quantity of water passed down, and upon the difference between room and water temperatures. The following figures will show the kind of difference obtainable after equilibrium has been established, in circumstances which would not be considered good on account of the somewhat large difference between room and water temperatures.

Table X.

Temp. of Water at Top of Tower—*i.e.*, Inlet-Water Temp. ° C.	Temp. of Water at Base of Tower, or of Sat. Air going to Calorimeter ° C.	Rise in Temp. of Water Film. ° C.	Room Temp. ° C.	Diff. Room Temp. and Inlet-Water Temp. ° C.
8·0	9·7	1·7	14·7	6·7
8·1	9·8	1·7	14·7	6·6
8·2	10·0	1·8	14·9	6·7

From these figures it would appear that, with a steady flow down the tower, the temperature of the air entering the calorimeter approaches more nearly to the inlet-water temperature than the room temperature, when there is a difference between the two. Lagging of the tower, which immediately comes to one's mind, is inadvisable, since, when only partially saturated air is introduced at the top of the tower, heat must be supplied to make good the latent heat of vaporization of the water necessary to saturate the air, this being supplied through the walls of the tower. The holes at D (fig. 2) admitting water to the tower are rather awkwardly placed for inspection and cleaning, so that it is a matter of difficulty to say whether or not a satisfactory film of water is running down the tower. Should adaptation to other apparatus be necessary, it is suggested that, by the use of suitable baffles, an equally efficient, but more compact, saturator could be devised.

Saturation of Incoming Air.

A number of tests of the humidity of the air entering the burner-box—*i.e.*, at the base of the tower—gave results ranging from 95 to 110 p.ct. at the inlet-water temperature; the humidity in the laboratory at the same time being 42-70 p.ct. The higher results, which are somewhat anomalous, are explained by an increase in temperature of the water film in passing down the tower, as detailed in the preceding section. The outlet products are very efficiently cooled, and pass out at a temperature usually not greater than 0·5° C. or 1° Fahr. above the inlet water. A slight increase in the saturation temperature of the inlet air of the same order is of no consequence, and will, in fact, neutralize the slight error due to the temperature of the outgoing products being above that of the inlet water.

It is not advisable, but if it should be necessary for any reason to work with inlet water at a temperature below the dew-point of the laboratory, the inlet pipes, saturating tower, and all the water vessels up to the calorimeter inlet, become wet and drip water. The enamel on these parts does not seem to stand well against this action; and we have two specimens of saturator towers which have corroded so badly as to be useless (not, however, belonging to this recorder). It is suggested that the tower might be constructed in a heavier gauge of metal.

Some matters relating to thermal measurements will now be discussed.

Thermometers.

The mercurial thermometers used in the non-recording portion of the calorimeter are discussed in Appendix I. (18), and means suggested whereby the accuracy of reading them can be greatly improved, when determining the C.V. for setting or checking the chart. As a general rule, the temperature measurement is the least satisfactory item of a C.V. determination; and during the past ten years a considerable number of papers have been read on the errors and corrections of calorimetric thermometers. On no account should untested thermometers be used in this class of measurement. It would seem to be commercially impossible to produce mercury-in-glass thermometers which have, and will retain, an accuracy of 0·05 °C. throughout their scale. The elaborate methods for calibration detailed in text-books of practical physics are only suitable for standard thermometers, and unless carried out by particularly competent and practised operators, are of doubtful value. On the whole, we incline to the opinion expressed by E. Griffiths ("High Temperature Measurements," Griffin, London, 1920), that the most satisfactory and most economical method of calibration is to have the thermometers calibrated against standard instruments at the National Physical Laboratory, and, where a number are in use, to employ these as sub-standards for direct comparison with other thermometers.

For the present work, a well-seasoned calorimeter thermometer, divided to 1·10° C., was standardized at the National Physical Laboratory, the calibration being given for steps of 2° C. to an

accuracy of 0·02° C., and for a depth of immersion suitable for a flow calorimeter. (N.P.L., 279-19.) Direct comparison with this thermometer, checked also by reference to a thermometer standardized by the National Physical Laboratory at an earlier date, was made for all thermometers used. [Appendix I. (18).] The following table is typical of the errors met with in quite good thermometers, and shows the correction to be added to the various thermometer readings. It has not been uncommon during the war to find calorimeter thermometers with errors of 0·2° and 0·3 C.—quite a serious matter on a 10° rise, and more important still in cases where smaller temperature rises are employed. The thermometers with this Boys calorimeter are exceptionally good specimens.

TABLE XI.—*Corrections to be Applied to Thermometers used in Present Investigation.*

°C.	N.P.L. 15. G.3160.	N.P.L. 19. No. 279.	Recorder.		Boys (Griffin).		Junkers.*		Reserve.	
			A.W. 3425.	A.W. 3420.	1817537	1817215	No. 18.	No. 6.	No. 15	No. 16.
0	−·04	−·10								
1										
2	−·06									
3										
4	−·06	−·12							−·08	
5					+·02				−·09	
6	−·06	−·14		−·02	·00	−·02			−·09	
7			−·10	−·02	+·02	−·01			−·10	−·10
8	−·06	−·14	−·09	−·01	·00	·00	−·13	+·07	−·10	−·10
9			−·12	−·06	·00	·00			−·12	−·11
10	−·04	−·16	−·13	−·06	+·01	+·03	−·10	+·10	−·12	−·12
11			−·12	−·07	+·01	+·05			−·11	−·11
12	−·04	−·16	−·13	−·08	+·02	+·04	−·10	+·10	−·11	−·11
13			−·13	−·10	+·02	+·04			−·09	−·11
14	−·04	−·16	−·13	−·13	+·02	+·04	−·11	+·10	−·10	−·12
15			−·13	−·12	+·04	+·05			−·10	−·11
16	−·02	−·16	−·13	−·10	+·04	+·06	−·12	+·10	−·08	−·09
17			−·14	−·09	+·05	+·05			−·07	−·07
18	·00	−·16	−·14	−·10	+·04	+·06	−·14	+·09	−·07	−·06
19			−·16	−·10	+·04	+·06			−·07	−·06
20	+·02	−·14	−·16	−·11	+·04	+·03	−·13	+·09	−·06	−·05
21			−·19	−·12	+·02	·00			−·06	−·04
22	·00	−·14	−·18	−·13	+·02	−·02	−·11	+·08	−·06	−·03
23			−·19	−·13	+·03	−·01			−·06	−·03
24	·00	−·12	−·18	−·13	+·04	−·01	−·12	+·06	−·06	−·03
25			−·15	−·13	+·03	−·01			−·06	−·04
26	·00	−·10	−·14	−·12	+·03	−·01	−·11	+·06	−·07	−·05
27			−·15	−·10	+·05	·00			−·07	−·06
28	·00	−·08	−·14	−·08	+·04	+·02	−·10	+·06	−·08	−·08
29			−·15	−·09	+·05	+·01			−·07	−·08
30	+·02	−·10	−·14	−·11	+·03	+·01	−·08	+·09	−·09	−·08
31			−·12	−·12	+·03	·00			−·09	−·09
32	·00	−·12	−·12	−·14	+·03	·00	−·07	+·09	−·11	−·10
33			−·12	−·16	+·01	−·01			−·10	−·10
34	·00	−·16			·00	−·02	−·05	+·11	−·11	−·10
35					+·02	−·01			−·12	−·09
36	·00	−·14			+·04	·00	−·02	+·12		
37					+·03	+·01				
38		−·12			+·02	+·02				
39					+·02	+·02				
40		−·12			+·01	+·02				

*Enclosed scale type.

DIFFERENTIAL AIR THERMOMETER (SEE FIG. 7).

This is the portion of the apparatus used for transferring the temperature indications to the C.V. chart.

It consists of two cylindrical vessels of stout tinned copper, each of about 800 c.c. capacity, forming the hot and cold bulbs of the thermometer respectively (H and Q, fig. 2). These are connected by fine metallic tubes to two sets of aneroid chambers.

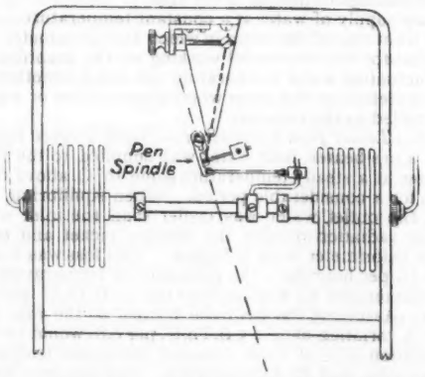


Fig. 7.—Differential Air Thermometer and Pen Mechanism.

There are six compartments in each set of aneroids, which are 3 in. diam. The aneroids are securely fastened ot a heavy iron frame, and are connected by a stout brass bar, from a point of which the pen mechanism receives its motion. The hot and cold bulbs are screwed into position, requiring some five or six complete turns to secure them. This means that, whenever either is removed for examination or cleaning, or for removal of the calorimeter body, connections to the aneroid chambers must be broken; and it is not desirable that this should be done frequently. As the sole object is to anchor the bulbs in their respective water chambers, a system of turn-buttons, or catches, or a bayonet catch, after the style employed in fastening electric lamps in their holders, and requiring only a fraction of a turn, would seem to possess advantages. Connections between the bulbs and their respective aneroids are made by screw unions, the actual joint being made between a plane and a conical surface—*i.e.*, line contact is employed. Although of an accepted design, some trouble has been experienceed in securing gas-tightness with these joints, especially after they have been made and broken a few times. The slightest leak is detrimental to the system, and it is to be remembered that the apparatus should remain perfectly tight for weeks on end.

Subject to an improved method of fixing the bulbs being adopted, a permanent soldered connection would, perhaps, be preferable, the final sealing of each bulb at atmospheric pressure being effected by the closure of small pinhole orifices with solder or sealing wax, as in the case of the old aerorthometer. The leaks causing trouble are often too small to be detected by soap solution, and usually show themselves by a gradual creep of the zero of the instrument. It will be seen from fig. 2 that, while the outlet mercury thermometer is placed in a tube passing through the axis of the corresponding air-bulb, the inlet mercury thermometer is in a different vessel from its air-bulb. When the inlet water differs from the room temperature, there is the possibility that the water surrounding the inlet air bulb will differ from that reaching the inlet mercury thermometer. The greatest difference we have observed is 0·2° C. equivalent to 10 B.Th.U. per c.ft. for a difference of 10° C. between inlet-water and room temperatures. It should be unnecessary to point out that such difference is prejudicial to the working of the instrument in other respects, and was used solely to obtain a temperature difference in the water supply at these two points which could be measured with certainty. In ordinary cases the maximum error should not exceed 1-5th to 1-10th of the amount noted.

A series of tests was made in which the temperature difference between the outlet and inlet water was varied in steps from 5° to 15° C. The proportionality between the observed temperature difference by the mercury thermometers and the motion of the pen on the chart was excellent. Owing to the manner in which the pen mechanism is loaded, the members causing motion are always maintained in tension, so that back-lash is non-existent.

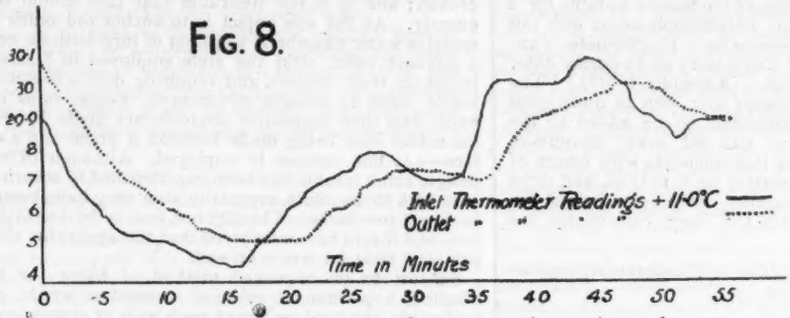
TEMPERATURE VARIATIONS OF INLET WATER.

For the successful working of the recorder, a steady inlet-water temperature is essential. Where eye-observation is being made, slight fluctuations are of little consequence, especially if the means of some ten readings each of inlet and outlet temperatures distributed at suitable intervals are used in calculating the C.V.

Prolonged and careful observation of the mercury thermometers at 15-second intervals showed that fluctuations of the inlet-water temperature were reproduced very closely on the outlet thermometer. Owing to conduction in the body of the calorimeter, and to its thermal capacity, there is a tendency for the peaks and hollows on the outlet temperature curve to be slightly less marked than on the inlet-water temperature curve (see fig. 8); and there is an interval between corresponding points on the two curves which is intimately connected with the rate of water flow through the calorimeter. By taking a number of inlet-water temperature readings at regular intervals, and a number of outlet-water temperature readings, with a suitable interval between corresponding pairs of readings, very little error need arise from a fluctuating inlet temperature; but readings must be taken strictly to time, if good compensation is to be effected. Even when temperatures are steady, the practice of relying upon single readings of inlet and outlet temperatures is to be strongly deprecated, and with fluctuating temperatures may lead to errors of 20 B.Th.U. or more in the data used for calculating the C.V.

With the differential air thermometers, which respond to changes in temperature with remarkable celerity, simultaneous readings of inlet and outlet temperatures are automati cally made and subtracted from one another. The time required for the inlet-bulb aneroid to react to a temperature change is only a fraction of the time needed for the water to pass through the calorimeter and the same temperature change to affect the outlet-bulb aneroid. In other words, temperature changes affecting the inlet bulb do not simultaneously affect the outlet bulb in such a way as to neutralize all temperature changes other than those caused by imparting heat to the water in passing through the calorimeter. The result is a wavy line upon the chart showing every variation in inlet-water temperature, superimposed upon variations due to change in C.V. (see fig. 9).

Where the inlet-water temperature is fluctuating a few tenths of a degree up and down, there is no great difficulty in determining a line on the chart which shall fairly represent the chart C.V. disregarding these minor fluctuations. It is an open question, however, whether the average line thus obtained represents the average C.V. of the gas supplied to the instrument. The irregularities thus referred to are usually only of a few minutes' duration; the fluctuations being about a general mean value, though individual oscillations may be as great as ± 25 B.Th.U. There is another class of fluctuation more difficult to detect. This may be due to a gradual and steady increase in inlet-water temperature from (say) 6 a.m. to noon. During this period, the chart will read slightly and systematically too low, the error being



Simultaneous Readings of inlet and outlet mercury thermometers shewing reproduction of inlet fluctuations on outlet, and time interval between corresponding readings on the two thermometers

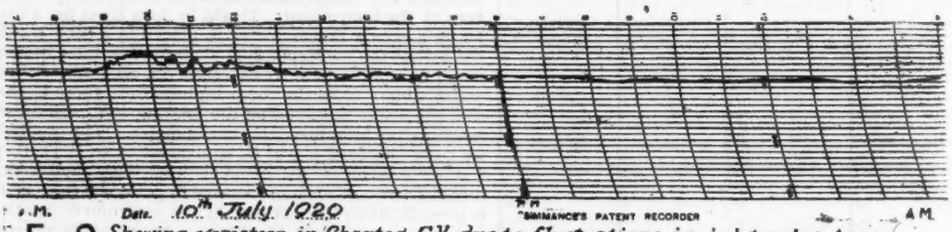


FIG. 9. *Shewing variation in Charted C.V. due to fluctuations in inlet water temp. Note fluctuation is more serious during daytime than at night.*

FIG. 10. *Shewing fluctuations of zero of a similar character with burner extinguished. (pen set up 30 B.Th.U. to keep record on Chart.)*

FIG. 11. *Sections of Charts shewing response to known changes in C.V. Note abruptness of changes in direction.*

roughly represented by the temperature rise taking place in the period required for the water to pass from inlet to outlet thermometer. The corresponding falling temperature from (say) 6 p.m. to 2 a.m. produces an error in the opposite direction; but there is no guarantee that the two errors will quantitatively neutralize one another over the 24 hours. If simultaneous, or nearly simultaneous, readings of inlet and outlet mercury thermometers are made, these errors may affect the charted and determined C.V. equally, and are consequently unnoticed They can, however, be detected if the readings are so distributed as to allow for the time lag on the water-stream between the inlet and outlet thermometers.

This problem of securing a water supply of very steady temperature is likely to be a serious one in many cases. It is suggested by the makers that the calorimeter should be installed in a basement or on a ground floor, and that water should be brought to it direct from the street-mains without an intermediate tank or cistern, making all connections as short as possible. This may not always be convenient or practicable. At Birmingham the calorimeter was installed in a first-floor laboratory, and water was originally taken from the laboratory supply. The short-period fluctuations referred to were extremely troublesome in the daytime, responding in a very sensitive manner to the varying demand for water in other rooms on the same floor. During the night time very steady charts were obtainable (see fig. 9). Although the possibility of the irregularities being due to irregularities in the gas rate or water rate had been almost definitely excluded, it was considered advisable to run the recorder for some days with the burner extinguished. Charts were obtained with similar characteristics—*i.e.*, a very wavy line with variations up to ± 25 B.Th.U. in the daytime, and a much steadier line at night (see fig. 10). The water supply on the ground floor was carefully examined, and found to be somewhat better than that on the first floor, but not sufficiently so to warrant the removal of the recorder to a fresh room on the ground floor less convenient in other respects. The fluctuations in water temperature on the ground floor were considerable. This may be put down to the fact that the laboratory is situated in an industrial area, with a very fluctuating demand for water both on the gas-works itself and in neighbouring works.

In the case of a testing-station in a district which is largely residential in character, such fluctuations would be much less marked, and a water supply taken direct from the street-mains might in such instances be quite satisfactory without any further treatment. Eventually the water supply was taken into a large tank on the roof of the laboratory, the calorimeter being supplied from this tank; and much steadier conditions were attainable. Though covered, this tank is unfortunately exposed to the weather, and at times the water falls much below room temperature—a serious disadvantage. The changes in temperature are as a rule not sudden. The tank is to be placed in the testing-room itself near the ceiling, and steps are being taken to secure thermostatic control of the water entering the tank; the water supply to the calorimeter being drawn from a point remote from the inlet, so as to take advantage of mixing in the tank.

A steady supply of water at a constant temperature, not greatly different from that of the room in which the calorimeter is placed, is essential for the successful working of the recorder. Errors due to fluctuating water temperature are not a function of C.V., and will therefore be the same whether gas of low or high C.V. is being supplied to the recorder.

Radiation Losses from Calorimeter.—Using a spare Boys calorimeter as a pre-heater, inlet water was supplied to the Simmance calorimeter at a steady temperature some 10° C. above room temperature, for a considerable period. When equilibrium had been reached, the outlet water was cooler than the inlet water, due to loss by radiation despite the wooden jacket and cover with which the calorimeter body is lagged. This loss was found to be 5·6 B.Th.U. per hour per 1° C. difference in temperature between the calorimeter and its surroundings (or 3·1 B.Th.U. per hour per 1° Fahr.). Assuming the gas to be burned at the rate of 2 c.ft. per hour, a variation of ± 1·5 B.Th.U. per c.ft. would be apparent for a variation of ± 1° Fahr. between the mean temperature of the calorimeter and its surroundings. The necessity for having a steady room temperature and a steady inlet-water temperature for exact work is evident, since the radiation gains and losses depend upon both of these. In calculating the mean temperature of the calorimeter body for evaluating radiation gains or losses, it should be remembered that only about one-quarter of the surface (forming a belt round the hot-water receiver at the top) exhibits the full temperature gradient due to the outlet-water temperature; the remainder is substantially at inlet-water temperature. The mean temperature difference between the calorimeter and its surroundings will therefore be given approximately

by the algebraic sum of one-quarter the difference between outlet water and room temperatures, and three-quarters the difference between inlet water and room temperatures.

If, as is recommended for other reasons, inlet water is supplied at room temperature, and a rise in temperature of 10° C. at the outlet is produced, the calorimeter will be losing heat equivalent to 7 B.Th.U. per c.ft.—an amount well worth attention. This loss will affect the mercury and recording thermometers equally; and the loss will therefore not be detectable by a check test in the ordinary way. The proposal to eliminate this error by working with the inlet-water temperature so far below room temperature (about 3° or 4° C. lower) that radiation gains and losses will balance one another, is difficult to maintain accurately over lengthy periods. An alternative is to work with inlet water at room temperature, and surround the upper portion of the calorimeter with a second water-jacket, insulated from the calorimeter body through which the outlet hot water flows before finally going to waste.

The Simmance calorimeter has not been found systematically low in its readings due to radiation losses when tested against the Junkers and Boys calorimeters. Either the latter calorimeters are subject to an error of a similar kind, or through fortuitous circumstances the temperature conditions at the time of testing have been such as to eliminate the error.

Variations in such radiations, gains, and losses might well account for certain deviations of the chart at different times of the day observable when working on gas of constant C.V.; but where these are accompanied by variations in inlet-water temperature, other effects contribute to the net result, as already indicated—*e.g.*, change of water rate and influence of gas cooler.

Pen Mechanism and Chart.

The chart used on the drum is one with equidistant lines, showing every 10 B.Th.U. from 0 to 700. As the chart is 5 in. wide, the distance corresponding to 10 B.Th.U. is 0·07 in. The width of the trace made by the pen corresponds usually to about 2 B.Th.U., so that its position on the chart should be determinate within ± 1 B.Th.U. The chart is pressed upon the rotating drum by a series of discs mounted on a framework, and this method of driving the chart by friction has proved entirely satisfactory. The lateral position of the chart is determined by the flanges on the clock drum. To allow for slight differences in the widths of charts, some clearance is necessary between the edges of the charts and these flanges. The average amount of lateral motion permitted in several specimens we have examined corresponds to 5 B.Th.U. As a general rule, some attempt has been made when setting the chart to place it in contact with the left-hand flange of the drum, but it has frequently drifted over into contact with the other flange, and back again. The printing of the charts has not always been good, and irregularities in the rulings amounting to 2 or 3 B.Th.U. seem to be periodic. Taking all these points into account, the chart value may be uncertain, to the extent of ± 2 B.Th.U., through imperfections in the apparatus provided for recording the C.V.

Pen friction, either at its pivots or on the chart, does not appear to be responsible for irregular records. In fact, the method of supporting the pen and the clock drum and chart is such as to reduce these to a minimum. Jumps of 2 or 3 B.Th.U. at times might be accounted for by slight stiffness of the aneroid chambers.

Proposals have been received to construct instruments with a limited C.V. range, which, by the use of charts of the same width as at present employed, would lead to a more open scale. It is, however, quite illusory to provide an instrument in which the precision of reading the record is greater than the accuracy with which the record is drawn. The present construction of the apparatus seems to be well designed in this respect, and the mechanism and chart are well proportioned. In all cases it is desirable that a zero position or datum line should be shown on the chart or on some part of the recorder in such a position as to be verified with ease; and such verification should be carried out at reasonable intervals.

Setting of Pen.

The air thermometer merely records the difference in temperature between the inlet and outlet water. What this temperature difference means when translated into B.Th.U. per c.ft., depends upon the gas rate and water rate. If the latter are constant, the leverage of the pen movement can be so adjusted that the chart readings agree with the changes in C.V. of the gas. This adjustment is originally made by the makers, and instructions are given that the C.V. is to be determined by the water flow calorimeter, and the pen set upon the chart to the value so obtained, when the unions to the aneroids are to be screwed up. When adjusted in this way, the subsequent record can only be correct if the gas and water rates are exactly those used in the original setting. This matter can be tested by extinguishing the burner and waiting some two hours until the inlet and outlet water temperatures are equal. The pen should then obviously return to zero.

An alternative plan, which seems to give almost identical results, is to seal the aneroids at atmospheric pressure with both bulbs at the same temperature and the pen set to zero, and then light the burner. The pen should move up to the correct C.V. as determined by direct observation. If, on adopting the latter plan, the recorded C.V. differs by more than 10 p.ct., or (say) 50 B.Th.U., from the determined C.V., the link which controls the ratio of aneroid movement to pen movement must be shortened or lengthened. This is a very troublesome matter; and it is difficult to make an exact adjustment with the mechanism provided except by repeated trial and error. Theoretically it should be unnecessary to disturb this link; but our experience with a varying gas rate, and to a more marked extent with a varying water rate, has shown the necessity for provision being made for a more sensitive adjustment in this connection. When the difference between charted and determined C.V. is less than 10 p.ct. (assuming always a correctly adjusted zero), exact adjustment can be rapidly and conviently made by turning a slow-motion screw which tilts a framework carrying the pivots of the pen. Under these conditions, the maximum error existing for a change of ± 10 p.ct. in C.V. will not exceed ± 1 p.ct., even with so great an error in the setting of the pen leverage as 10 p.ct.

It is considered preferable to keep a record of slight variations in the difference between charted and determined C.V., rather than to adjust the position of the pen at all frequently. The error determined at the last test can be shown on a slate or tablet placed so as to be conveniently seen by those who have reason to use readings for process control.

Determination of Net Calorific Value.

Attention is nowadays directed almost exclusively to the gross C.V. of gas. It may, however, still be necessary to determine upon occasion the net C.V. In the Simmance calorimeter the condensed water from the products of combustion falls into a flat-bottomed annular dish of rectangular cross-section. A ¾-in. elbow projecting slightly into this dish provides an overflow for the condensed water which passes through a small spout and piece of rubber tubing to the waste tank. The connection for this acid condensed water is flush with the side of the waste tank, and soon corrodes a hole immediately beneath the connection. The water should be projected clear of the side by a small spout. The condensed water can be collected in a small measuring cylinder by slipping off the rubber tube from the drainage spout. On account of the small gas rate (2 c.ft. per hour), it is necessary to wait some considerable time in order to collect sufficient condensed water for an accurate measurement. The water also seems to build-up round the overflow and to be discharged in rushes of 4 or 5 c.c. at a time. This makes the calorimeter somewhat defective for the determination of net C.V.'s.

Comparison with other Calorimeters.

Throughout the tests the direct observations on the Simmance calorimeter have been accompanied by simultaneous tests on the same gas stream using Boys and Junkers calorimeters.

On the whole, the agreement has been excellent, and a few values only need be given in illustration.

Table XII.

Boys.	Junkers.	Simmance.
507·8	..	506·9
508·1	..	507·4
508·1	..	508·4
507·9	..	507·6
..	493·8	492·8
..	493·2	493·2
..	493·6	493·2
..	450·2	450·0
..	451·0	450·8
..	450·6	450·8
487·8	489·1	488·0
488·2	488·0	487·4

No appreciable reduction in efficiency in heat absorption due to corrosion in the gas or water passages of the calorimeter was determinate at the end of nine months' testing, though parts of the apparatus round the outlet for the products of combustion were rather liberally coated with copper sulphate.

Completeness of Combustion.

No systematic tests for completeness of combustion were applied, as the excellent agreement with the Junkers and Boys calorimeters showed that there was no chance of extensive error due to this cause. Further, it was found by trial that the gas rate could be increased by 50 p.ct. by loading the governor, or the outlet for products of combustion be throttled to cut-down the volume of air entering the calorimeter, without appreciably affecting the determined C.V. The chart value was, of course, considerably altered by such treatment.

Response to Changes in Calorific Value.

When started all cold, the record rises very rapidly, and at the end of one hour is in general within 10 B.Th.U. of its final equilibrium position when supplied with gas of constant C.V.

Cooling-down seems to be a slightly slower process; and though the apparatus is nearly cold in half-an-hour, it is practically two hours before both inlet and outlet thermometers reach strictly the same temperatures. In fig. 11 a few typical charts are given. Only the critical portions are shown, in which a change has been made from an experimental holder to the town supply, or from one holder to another on the town supply. It is to be noted that the change in the indications of the recorder is very abrupt and sharp, a feature somewhat surprising in view of the large thermal capacity of the calorimeter and the low gas rate. Other charts show that for variations in C.V. (say) up to ± 25 B.Th.U., the recorder responds extremely well, the changes

FIG. 12. *Simultaneous records with Beasley & Simmance Recorders on Gas of Variable Quality.*

being fully established on the chart in ten minutes to a quarter-of-an-hour after the gas of changed quality reaches the inlet to the calorimeter meter. In fig. 12 two records are shown on the same chart, made with the Simmance and Beasley recorders respectively. For convenience, one record has been raised relatively to the other so as to separate the two curves. The gas quality was of a fluctuating character, and both instruments follow the changes well; but the Simmance recorder is clearly the sharper in its indications.

SUMMARY.

SIMMANCE TOTAL-HEAT RECORDER.

The following summary is based upon our investigation of, and experience with, the instrument, and consideration of the results obtained.

(1) First, as to the control of the gas rate—an essential point in a recording calorimeter. The governor automatically compensates satisfactorily within certain limits for changing specific gravity of gas supplied to it, and for changes in atmospheric temperature and pressure. The range of temperature and pressure over which governing is satisfactory depends upon the specific gravity of the gas. Theoretical considerations indicate the following maximum systematic changes in the gas rate, for an instrument adjusted at 60° Fahr. and 30 in. bar., and subjected to temperature changes ranging from 50° to 70° Fahr. and barometric changes of 28·5 to 30·5 in. (see Table VII.).

For sp.gr. 0·4 (*e.g.*, rich coal gas), + 0·5 p.ct. to − 0·6 p.ct. or ± 0·5 p.ct. about a mean value.
For sp.gr. 0·5 (*e.g.*, ordinary town gas), + 0·6 p.ct. to − 1·8 p.ct. or ± 1·2 p.ct. about a mean value.
For sp.gr. 0·6 (rather abnormal), + 1·4 p.ct. to − 2·9 p.ct. or ± 2·2 p.ct. about a mean value.

With the much smaller variation of laboratory temperature likely to be experienced over a period such as a day or a week, this error would be decreased to a corresponding degree. The change in gas rate caused by a change in the specific gravity of the gas, for given conditions of temperature and pressure, may be determined by interpolation using the data given in Table VII. for the sp.grs. 0·4, 0·5, and 0·6. The changes will in general fall within the limits given above.

(2) Our tests have shown at times a further change in the gas rate due to slight mechanical defects, mainly in the burner, limited to about ± 1 p.ct. if the burner receives daily attention, but otherwise liable to be progressive. It is, however, believed from our observations that, with a later type of calorimeter, this difficulty will not be encountered, and that the variation in governing will only slightly exceed that indicated under (1), even with the wide variations of temperature and pressure taken.

(3) Control of room temperature is desirable, and improves the governing, but the precautions necessary to secure closer regulation than ± 5° Fahr. are not accompanied by a commensurate improvement in governing. Closer regulation is necessary for other reasons, connected chiefly with radiation gains and losses from the calorimeter.

(4) With respect to the water rate, which should be constant—this had a tendency to slow down gradually, and could not be depended upon to remain constant within 1 p.ct. for more than a day or two. With the water used at Birmingham, derived chiefly from moorland sources, there was a more or less regular decrease in the water rate of 0·5 to 1·0 p.ct. per 24 hours, due to a deposit of slimy material. This seriously restricts the period over which the instrument may be left unattended, without the errors accumulating above a permissible amount; while the water passages of the instrument are not easy to clean in a satisfactory manner.

(5) Excellent provision has been made for freeing the water from air, and no irregularities in the water rate have been traceable to air-locking with the instrument examined.

(6) On account of changes in viscosity of water with temperature, there is a change in the water rate of approximately 0·7 p.ct. per ° C. (0·4 p.ct. per ° Fahr.) change in temperature of the inlet water. There is also a change in the water rate of 0·3 p.ct. for each ° C. change in the difference between inlet and outlet water temperatures.

(7) With respect to errors under (4) and (6), a later modification of the recorder offers a prospect of control of the water rate within ± 1 p.ct. over considerable periods (See Appendix II.).

(8) The air saturator eliminates errors due to variable humidity of the atmosphere.

(9) The recording mechanism indicates satisfactorily the temperature differences between inlet and outlet water.

(10) We had great difficulty, which may be experienced elsewhere, in obtaining a water supply which will yield a steady and satisfactory inlet temperature. Errors in the charted C.V. due to fluctuating inlet temperature may be very considerable.

(11) Given a steady inlet-water temperature, the outlet temperature is steadier in this than in any other calorimeter we have yet examined, presumably owing to the special construction of the calorimeter head.

(12) The calorimeter is liable to radiation gains and losses equivalent to ± 1·5 B.Th.U. per c.ft. for each ° Fahr. difference between the mean temperature of the calorimeter body and that of its surroundings.

(13) The direct results obtained with the non-recording calorimeter agree with those from the Junkers and Boys calorimeters, when the results of the latter are fully corrected for atmospheric humidity, within the limits of experimental error—*i.e.*, the same C.V. to ± 0·5 p.ct. should be obtained whichever of the three instruments is used for a determination.

(14) The Simmance recorder responds extremely well to changes in C.V. of the gas supplied to it, and changes of ± 25 B.Th.U. are fully established on the chart in from ten minutes to a quarter-of-an-hour from the time at which the gas of altered quality reaches the calorimeter.

(15) With respect to the instrument as a continuous recorder, it is not possible to make a statement which shall be unconditionally true and apply unreservedly to the various conditions of use likely to be encountered in practice. The behaviour of the governor and temperature recording device is in good general agreement with the makers' statement. Errors introduced by corrosion of the burner, and more especially by the character of the water supply, are not regular nor subject to precise mathematical expression; and individual experience is likely to vary greatly.

(16) For control of gas manufacture, for large consumers of gas, and for research purposes, where the necessary staff is available for daily inspection and adjustment (if necessary) of the recorder, it is likely to prove a valuable instrument. Under such conditions the record may be relied upon to within ± 1 to 1·5 p.ct. over 24 hours, and therefore if adjusted every day will continue to be correct within those limits.

(17) With respect to longer periods and general conditions of use, no definite statement is possible. If left unattended, for example, under the conditions of testing at Birmingham (by no means abnormal), the recorded calorific value would be doubtful at the end of a week, and almost certainly useless at the end of a month. It will be readily understood, however, from the preceding analysis of the way in which the errors arise, that if the instrument can be used on gas of sp. gr. 0·40 to 0·45, with a suitable water, and with very small temperature variations in water and surrounding air, the liability to error is greatly diminished thereby, and satisfactory records may be obtained over considerable periods without the amount of attention necessary in less favourable circumstances.

(18) Although so good an instrument in many respects, the recorder we tested could not, in our opinion, have been rightly made the basis of monetary charges or penalty clauses under the Gas Regulation Act, unless installed under present conditions and subjected to continuous skilled supervision.

(To be continued.)

Shipston-on-Stour Gas Light, Coke, and Coal Company.—A Company has been registered, with a capital of £2000 in £1 shares, to take over the business of the Shipston-on-Stour Gas, Light, Coke, and Coal Company, recently acquired, and now carried on, by Mr. H. G. Eveson, and to manufacture, sell, and supply gas for light, heat, and power in Shipston-on-Stour and surrounding districts, &c. The first Directors include Mr. J. R. Duff, of the Banbury Gas-Works.

Oswaldtwistle Gas Accounts.—Figures were quoted at last week's meeting of the Oswaldtwistle Urban District Council from the annual report of the Gas Committee. During the year ended March 31 the works supplied 95,456,000 c.ft. of gas, an increase of 4,298,000 c.ft. over the previous year. There was a yield of 13,344 c.ft. per ton of coal, as against 13,025 c.ft. The expenditure of £27,579 showed an increase of £6996, due largely to higher wages, &c., while the total income of £33,466 exhibited an increase of £8407. The net profit amounted to £3409—a gain on the previous year of £1357. It was stated that the original loan of £35,800 borrowed when the gas-works were erected in 1869, had now been paid off; and the total debt stood at the low figure of £7112. Intimation was made that, as soon as possible, there would be a reduction in the price of gas.

CORRESPONDENCE.

[We are not responsible for opinions expressed by Correspondents]

How it is Done.

SIR,—In your issue of June 8 you published in full Mr. Helps's lucid and complete evidence before the Inerts Committee; and I have read this with very great interest and profit.

In the columns of the "JOURNAL" I have previously agreed to differ with Mr. Helps's financial conclusions on the subject of the manufacture and supply of low-grade gas; and after reading the estimates he gives in the evidence in question, I am more than ever convinced that Mr. Helps is at sea when he reaches his favourite "stunt" of three times the gas for the same money. Mr. Helps shows in his figures how it cannot be done. He first creates a business of three times the thermal sale. He claims (and with a large amount of experience and evidence behind him) that low-grade gas can be burnt with greater efficiency than high-grade gas, and therefore his proposals may mean the creation of a business nearer four times the effective sale.

If we assume a 300 B.Th.U. gas (which has been frequently mentioned in this matter), it involves the manufacture and distribution of at least five times the volume of gas. This huge increase of business is to be run on exactly the same cash expenditure (except manufacturing costs) as the present business—*i.e.*, Mr. Helps assumes that not one single penny extra will be spent in running a business selling three times the number of therms which the Gas Light and Coke Company sell to-day.

I do not propose to criticize these figures in detail, as the above broad statement is sufficient to prove the fallacy of the argument. There are one or two points, however, to which I would like to draw attention. In his table of the present practice of the Gas Light and Coke Company, Mr. Helps takes the actual figure of 2,279,253 tons of coal, and then calmly adds on 30 p.ct. more of coal, which the Gas Light and Coke Company do not use. He therefore arrives at a figure of 5·3 million B.Th.U. per ton, which is obviously incorrect. With reference to his own figures for residual receipts, he estimates to get 22 p.ct. of the cost of coal back from the residual products. I should imagine that, after obtaining 20 million B.Th.U. per ton of coal, there would have to be some high tar and sulphate returns in order to obtain 22 p.ct. of the cost of the coal back—viz., 8s. 11d. per ton.

With reference to the repairs and maintenance of works and plant, Mr. Helps claims to be able to provide this expenditure at one-third the cash with three times the thermal sale—*i.e.*, he claims that repairs on his system can be done for one-ninth of the sum per therm, or one-fifteenth of the cost per 1000 c.ft.

Rent, rates, and taxes are still kept at the same figure with three times the business. Does Mr. Helps suggest that no more profit will be made on this huge business and no more liability for taxes?

With regard to repairs and maintenance of mains and services, no more cash is allowed, although at least five times the volume of gas is handled; and I doubt even with high-pressure mains whether this could be done in view of the provision for maintenance of the various boosting plants, governors, &c., necessary.

I am aware that Mr. Helps does not believe in the meter, stove, and coin-meter installation business. He accordingly cuts this expense out in both comparisons; and to this extent he is fair. But I think, on the other hand, some reduction in distribution expenses, management costs, storekeeping, &c., could be effected in the cost of present practice, and so reduce existing costs. At the same time, how are we to look for an almost immediate increase of three or four times our business if we are to throw the whole of these services overboard?

I will now turn for a moment to the Nuneaton present figures. Mr. Helps's own figure gives a production of gas of less than 50 therms per ton for an average gas of 320 B.Th.U. Where is the merit in low-grade gas from the financial point of view? The South Metropolitan Company, making and selling a gas of 550 B.Th.U., produced 69 therms per ton of coal. I should like to know exactly how much gas per ton, and of what quality, Mr. Helps has in mind as his ideal in producing 200 therms per ton.

He now has the opportunity, under the Gas Regulation Act, of putting his precept into practice. If his directors at Nuneaton are satisfied that he can reduce the total cost of manufacture from 8·61d. per therm at present to 2·61d. per therm as proposed, they would be lacking in business ability if they did not immediately take steps to completely reorganize their undertaking on the lines advised by their technical expert.

June 23, 1921. ENGINEER.

"Declared" or "Supplied" Calorific Value.

SIR,—I have read with interest the letters of Mr. Ibbs and Mr. Day on the above matter.

I think it highly desirable that in all tabulated statements we should base our figures on the calorific value "declared." With the object of giving full credit to the carbonizing results, I suggest that the "gas made" be divided into two headings—viz.:

Therms actually manufactured.
Therms adjusted to declared calorific value.

In the first column could also be stated the average calorific value of gas manufactured. This would show at a glance the unavoidable loss sustained in making more therms than can be charged for. The remaining columns in the gas table, such as "Sold by Private Lights," "Sold by Contract," "Used on Works, and Unaccounted-for," would then total-up as at present; and there would still be the real leakage, which is represented by "unaccounted-for" gas.

I am of opinion that this way is preferable, in view of the fact that the gas sold must be sold according to the "declared" value, and not to the "supplied" value.

All rental books and statements will be automatically made up on the basis of therms charged for; and unless this preliminary adjustment is made, there will always be complications arising due to the percentage difference of the supplied and made, which would never be the same for two undertakings.

I agree with Mr. Ibbs that the only unit for the future "Field's Analysis" is the "therm." As Mr. Ibbs points out, the calculations will have to be made to three places of decimals; but, as a matter of calculation, this will involve no more work than taking the 10-unit basis worked to two places of decimals. I cannot see that a figure of (say) 11·802d. per therm will be any more cumbersome than 118·02d. per unit of 10 therms.

June 23, 1921. ENGINEER.

REGISTER OF PATENTS.

Preventing Condensation of Moisture in Gas-Heated Apparatus.—No. 147,732.

JUNKERS, H., of Dessau, Germany.

No. 19,735; July 8, 1920. Convention date, Jan. 13, 1919.

This invention relates to appliances in which combustion or heating gases are led along cooled metal partitions—such as heaters for liquids, steam generators, and the like—having a cooled shaft or flue for, and in contact with, the rising gases. Appliances of this kind as heretofore constructed have (the patentee points out) possessed the defect that, owing to radiation, the temperature of the walls of the shaft or flue at the side in contact with the gases is lower than the dew-point of the gases, so that moisture from these gases condenses upon the inner wall of the shaft or flue. Experience shows that this condensation assists the chemical action of the gases upon the shaft walls to a very large extent, and is the cause of the rapid destruction of the walls.

In order to prevent the condensation of the moisture, it has been proposed to coat the cool walls exposed to the heating gases with a material of lesser thermal conductivity. This method, however, has several disadvantages, since the material suitable for such coating (asbestos, for example) has very little strength, and is thus easily damaged. Therefore special precautions have to be taken to protect it. Besides, it is difficult to fasten such a coating to the walls of a liquid heater. Further, such a coating acts also as a non-conducting material, and the heating effect of the cooled wall is considerably re-duced.

According to the present invention, the condensation on the cooled walls is prevented by arranging a further metal wall in contact with the heating gases at a certain distance in front of the main wall to be protected. This further wall is connected with the main wall at certain intervals by a heat conductor. The effect of this arrangement can be seen from the following: If the main wall be unprotected, the heat of the gases is transmitted everywhere through the wall into the liquid—that is to say, it has to overcome only the comparatively small thermal resistance of the main wall, depending upon its thickness, so that only a small fall of temperature is caused. With the arrangement according to this invention, on the other hand, the heat transmitted to the protecting wall has to be conveyed therein through a considerable distance until it is transmitted to the main wall at the points where the protecting wall and the main wall are connected, and thence into the liquid. Owing to the longer distance the heat has to traverse, a greater difference in temperature between the two walls is caused—that is to say, the protecting wall will be hotter than the main wall. As the entire heat entering the protecting wall must flow through the comparatively small points of contact with the main wall, at these points a particularly powerful flow of heat is obtained which cannot be maintained except by a greater drop in temperature; so that also at these points the temperature of the walls will be considerably higher on the side facing the gases than in the cooled shaft walls directly exposed to the heating gases.

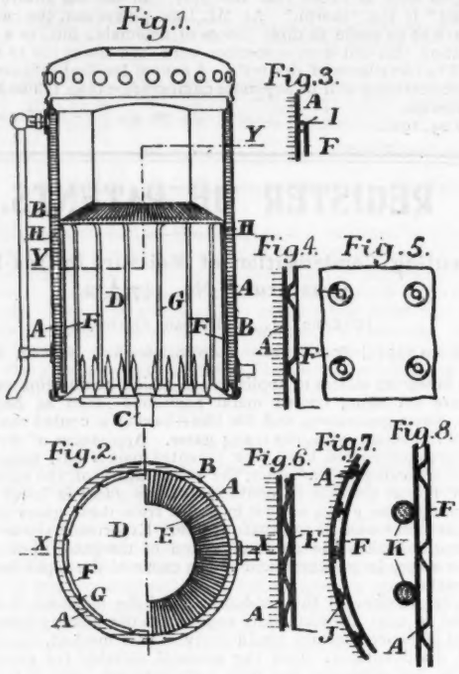
The apparatus can be so constructed, either by experiments or calculation, that the drop in temperature required for transmitting the heat from the protecting wall to the liquid becomes so high that the temperature of the protecting wall is higher than the dew-point of the heating gases. Thus the protecting wall remains perfectly dry, and is effectively protected from the chemical influences of the gases. On the other hand, the temperature of the protecting wall cannot become unduly high, as the heat transmitted thereto is conducted through the points of connection into the main wall and thence into the cooling medium. In order to ensure an exact regulation of the temperature of the protecting wall in those places where the cooling medium still has a lower temperature, the points of contact may be arranged at a greater distance from each other, so that the path traversed by the heat in the protecting wall increases, and the difference of temperature between the latter and the cooling medium is greater than in those places where the cooling medium has a higher temperature. Since the main wall is no longer in contact with the gases, no moisture can settle on it.

In order to ensure that the gases do not reach the main wall, and to prevent the combustion gases from entering the small interstices between the protecting and the protected walls, the arrangement may be further improved by closing the interstices at the edges of the protecting wall.

Fig. 1 is a vertical section of a heater on the line X in fig. 2. Fig. 2 is a horizontal section on the line Y in fig. 1. Figs. 3 to 8 show various constructional details.

As shown, the heater comprises an annular tank confined by the inner wall A and the outer wall B. At the lower end of the tank a burner C is placed. The heating gases flow first through a shaft D formed by the lower part of the heater, and then enter the radiator E, in which they lose most of their heat. They leave the heater through the top opening of the cap. Inside the shaft, at a short distance from

the inner main wall of the tank, a metal protecting wall F is arranged. This wall has vertical grooves G, the bottom of which are in thermal connection with the cooled main wall. The top end of the wall F is bent-back at H in the direction of the wall A, so as to prevent the gases from entering between the walls.



An Improvement in the Junkers Calorimeter.

This opening may be closed in any other way—for example, by inserting a packing ring I of a material able to withstand the heat, as shown in fig. 3.

The construction of the connecting pieces between the main cooled wall A and the protecting wall F can be carried out in various ways. Instead of vertical grooves, horizontal grooves may be arranged.

A further modification is shown in figs. 4 and 5. Here the protecting wall F has saucer-like indentations, the bottom faces being connected to the cooled wall A. The projections, grooves, or the like connecting the two walls may also be provided in the cooled wall A, if desired.

For transmitting the heat from the protecting wall F to the main wall A, separate intermediate bodies may be arranged which are in thermal connection with both walls. An example is shown in fig. 6, wherein a third corrugated wall is inserted between walls A and F, transmitting the heat from the wall F to the wall A.

The thermal connection between the protecting and the cooled wall may be accomplished by soldering, welding, or by mere pressure. A modification of the last-named type may be seen in fig. 7, wherein the protecting wall F of a cylindrical flue is formed with a series of segmental portions, the ends of which are provided with short, bent portions J, which rest against the wall A. By the spring-like action of the curved back faces of the wall F, when fitted into the flue under pressure, a lasting pressure of the portions J against the cooled wall A is ensured.

Fig. 8 shows an example of the invention applied to a wall which is not cooled continuously but in zones. The cooling of the wall in this case is performed by a liquid contained in pipes soldered upon the wall A at certain distances apart. The protecting wall F is in this case so connected with the wall A that the portions connecting both walls each lie between two cooling pipes K. The heat entering the protecting wall F can only flow in this wall to this connecting place, and then through the wall A to the connections of the pipes K before it reaches the liquid. Through this lengthy passage of the heat, the temperature of the protecting wall well above the dew-point of the heating gases is said to be obtained with great security.

Gas Purifiers.—No. 163,095.

FIRTH BLAKELEY, SONS, & CO., LTD., and BLAKELEY, W. of Leeds.

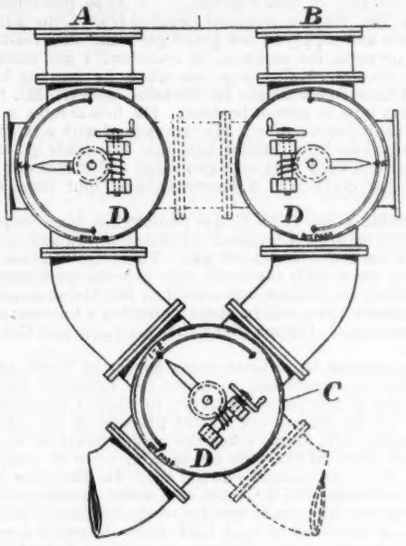
No. 3860; Feb. 9, 1920.

This invention relates to an arrangement of pipe connections with reversing and bye-pass valves for controlling the direction of the flow of gas in relation to two purifier boxes; the chief object being to allow the gas to be bye-passed or to pass up hill or down at will. Each purifier box has two pipes communicating with a valve, which controls three ways, and each valve, is arranged in communication with the other and also with a third valve, which controls three ways and is arranged in communication with an inlet and outlet pipe.

A plan is given showing the invention applied to two purifiers.

A indicates the first purifier box, and B the second purifier box—both with appropriate valves. C is a third valve, with pipes which connect it with the first and second valves.

In the first modification, each valve comprises an inverted cup centrally mounted in a cylindrical casing and having a branch opening arranged to be moved opposite to any one of three openings in the casing. The side of the inverted cup that is opposite to the branch opening is advantageously fitted with spring-pressed plungers, which bear against a machined surface in the casing to keep the face of the branch opening in contact with a seating in the cylinder. The latter comprises an upper and a lower portion bolted together. The lower portion has a branch opening at the side and a central opening at the top, and extending around the opening is a raised circular channel, in which the lower edge of the cup rests. The top of the latter is formed with a square recess to allow a driving connection with a square head on a shaft which is actuated by worm gearing from a hand-wheel.



Firth Blakeley & Co.'s Purifier-Valve Arrangement.

Rigidly fixed on the shaft is a pointer, which acts in conjunction with three indication marks on the casing to show the position occupied by the valve.

When the opening in the valve is opposite to an opening in the casing, gas can travel through this opening, through the cup-shaped valve, and through the opening in the lower portion of the cylindrical casing. By arranging the valves and pipe connections in this way, the direction of flow in either box can be reversed at will—either or both boxes and valves can be bye-passed, or the gas can be caused to flow from one box to the other, or *vice versâ*.

Distillation of Coal Tar.—No. 163,199.

TINDALE, H., of Abbotsford, near Sydney, New South Wales.

No. 10,924; April 20, 1920.

This invention is particularly suitable for the treatment of low-temperature tars, blast-furnace tars, vertical and horizontal retort tars, and producer gas and similar tars.

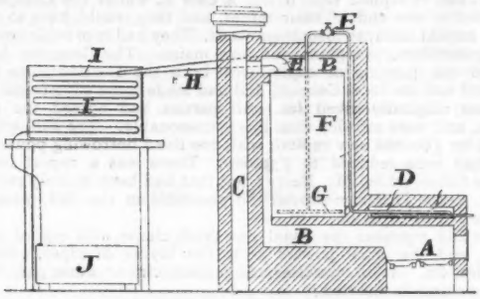
Research continued from time to time, says the patentee, has shown that coal tars can be resolved into four main constituents—namely, oils boiling up to 300° C. free carbon, petrolenes, and asphaltenes—the last three forming the constituents of pitch. Of these constituents, the asphaltenes are the most desirable, especially for use in road construction and other purposes in which pitch is employed.

To obtain a tar satisfactory for road-making purposes, it is essential to have a definite ratio between the proportions of asphaltenes and petrolenes present in the pitch. It has been found that in a pitch obtained from horizontal retort tar, the quantity of asphaltenes present varies between 35 and 40 p.ct. and the petrolenes between 40 and 50 p.ct. by weight. The quantity of asphaltenes present in a pitch obtained from vertical retort tars and low-temperature tars varies between 25 and 30 p.ct. by weight, and the petrolenes between 55 and 65 p.ct. by weight.

According to the present invention, the tar is so treated that the resultant pitches contain any desired quantity of asphaltenes and petrolenes, or, if necessary, the same quantity of asphaltenes and petrolenes as are present in horizontal retort tar pitch. These results are obtained by first dehydrating the crude tar, by any of the usual methods, and passing it into stills, which with their respective swan-necks are externally heated and suitably lagged in order to prevent the vapours which have been generated condensing back into the tar in the still. The stills are provided with a superheated steam-coil (preferably one to each still) placed above the heating furnace; and the tar is distilled in a current of superheated steam which is caused to pass through it. In addition to fire heat, it is known to employ superheated steam, and also air, in the distillation of tar—the steam or air usually serving the purpose of agitating the mass undergoing distillation and preventing its coking. The temperature of the tar should not exceed 300° C.

An essential feature of the process is that distillation is continued and the oils thereby removed until the asphaltenes and remaining petrolenes have reached the desired proportions; or, if necessary, removal of the oils may be facilitated by distilling under a partial vacuum. The percentage of asphaltenes present in the residual pitches may be increased by blowing air through the pitch for from two to twenty-four hours, according to the amount of asphaltenes contained in the pitch and the consistency of the product desired—vary-

ing from the consistency of treacle to a solid. The resultant product is then run out into containers and there allowed to cool to a temperature convenient for handling.



Tindale's Coal Tar Distillation Plant.

An elevation (partly in section) is given of an apparatus in which the process may be carried out. A is a furnace provided with a flue B and a chimney C. Above the furnace is a superheated steam coil D, steam from which is conducted by a pipe up to the flue and externally. A control cock E is fixed on this pipe, which is brought down into the flue and through the still F near the bottom, where a perforated steam spreader G is fixed. The distillation gases are carried over the lagged swan-neck H to the condenser I, from which a pipe conducts the oil to the receiver J.

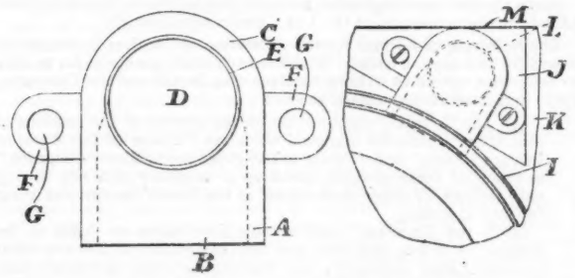
Provision is made for charging the still with tar and for withdrawing the pitch residues therefrom after distillation into containers for cooling. And if desired, the pitch obtained may be fluxed or softened with oil while hot, so that the resultant mixture is of the desired consistency. It has been found that aromatic oils—that is, those derived from the distillation of horizontal and/or carburetted water gas tars—make the most suitable fluxes or solvents; but in the event of these oils not being procurable, a suitable portion of the oils derived from the distillation of the crude tar may be used for fluxing.

Dry Gas-Meters.—No. 163,223.

ANDERSON, J., of Edinburgh.

No. 16,879; June 22, 1920.

This invention relates more particularly to a gas-way for leading the gas to and from the measuring chamber or chambers of the meter. It is especially useful in connection with meters as described in patents Nos. 13,025 and 13,026 of 1915.



Anderson's Dry Gas-Meter Gas-Way.

The invention consists in a connection for use in the construction of dry gas-meters, comprising a casting open at one end adapted to enter the side of a measuring chamber and with an opening on one face preferably circular adapted, by the aid of a spigot-fit, to register with a gas-passage formed in a gas-way box secured between the vertical and horizontal division plates.

A section of the casting is shown, and as applied in a gas-meter.

The gas-way is a casting A of rectangular section and with a rectangular opening B at one end terminating at the other in a dome C. The face is provided with a circular opening D and a spigot E of circular form concentric with the dome. Two lugs F standing out from the side are drilled with holes G for the reception of screws.

In applying this gas-way to the measuring chamber described in patent No. 13,025 of 1915 (here illustrated) an opening is cut in the side wall I of the chamber for the reception of the rectangular end of the gas-way, which is soldered into the opening. A box J is attached between the horizontal division plate M and the vertical division plate K of the meter, and leads to the valve mechanism. This box is formed with a circular aperture L adapted to take the spigot of the gas-way, which is preferably detachably secured to the box by screws.

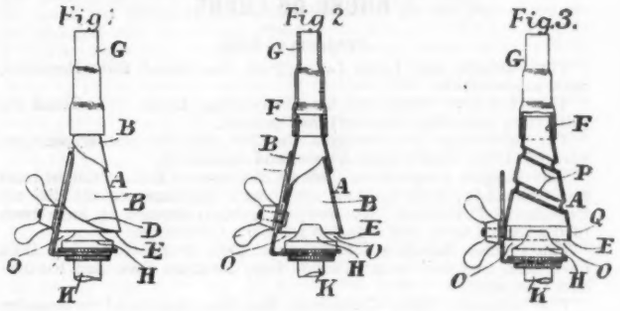
Bunsen Burners.—No. 163,354.

FORRESTER, C. J., of Gorton, Manchester.

No. 27,238; Nov. 6, 1919.

According to this invention, the mixing tube of the bunsen burner is of conical construction, with a spiral or screw-like part constituted by the wall of the tube or by a part provided thereon, whereby a whirling or gyratory movement is imparted to the gas and air passing through the tube, so that they are intimately mixed.

Fig. 1 is an elevation and fig. 2 a central vertical section of one arrangement of mixing tube (adapted for use with an incandescent gas-burner), and fig. 3 is an alternative construction.



Forrester's Bunsen Burner.

In figs. 1 and 2, the conical mixing tube A is formed of a series of spirally arranged convolutions B, each of conical form and tapering towards the outlet end for the mixed air and gas. Each tapering end extends into the base of the succeeding convolution, with a space between the basal edges and the outer surface of the tapering convolution extending into them. The lower end E of the mixing tube is finished off at right angles to the axial line of the tube; while the upper end is continued as a tubular portion F for the attachment thereto of the burner tube G.

The tube A is adjustably supported over the gas-nozzle H on a slotted bracket provided with an apertured part adapted to take on to the threaded end of the gas supply pipe K to which the nozzle H is attached; the apertured part being disposed between the nozzle and an annular rib on the pipe when secured in position. The mixing tube is adjustably secured to the bracket by clamping between a headed bolt and a butterfly nut.

The air admitted at the lower end of the tube has imparted to it a whirling movement by contact with the spiral convolutions; and in this mixed condition the gas and air pass to the burner. The spaces between the convolutions admit further supplies of air to the mixing chamber, should the supply at the lower end be insufficient; and thus any slight variations in the pressure of the gas supplied to the mixing tube are provided for, in addition to the means of adjusting the air inlet O between the mixing-tube and the gas jet or nozzle for regulating the main supply of air. By constructing the mixing tube of spiral convolutions, the effect on gas-mantles of vibration occurring in the gas-burner fitting are said to be considerably minimized.

In the construction shown in fig. 3, the mixing tube A is provided with an inwardly projecting spiral rib P (formed by grooving the outer surface of the tube) and with a cylindrical skirt portion Q (on its lower end), adjustably clamped to the bracket as in the other construction.

APPLICATIONS FOR PATENTS.

[Extracted from the "Official List" for June 22]

Nos. 16,174 to 16,818.

BAILEY, A. W.—"Bowls for reflected lighting." No. 16,194.
BALDWIN, J. V.—"Liquid flow meters." No. 16,240.
CLIMIE, W.—"Plant for the generation and treatment of gas." No. 16,469.
COE, A.—"Controllable steam-appliance for vertical retorts." No. 16,299.
ELKINGTON, R V.—"Safety device for gas-taps or taps on brackets, &c." No. 16,666.
GOAD, F. L.—"Fluid meters." No. 16,389.
HELPS, G.—"Gas manufacture" No. 16,183.
HIBBERD, C. E.—See Goad. No. 16,389.
HOWELL, P. F.—See Baldwin. No. 16,240.
KEILLOR, F. B.—"Combination plant for manufacture of coal gas, blue water gas, and coal tar or oil gas." No. 16,622.
KING, F. H. W.—"Coin-freed gas-meters." No. 16,654.
KOLLER, K.—"Grates for gas producers." No. 16,740.
LEES, A.—See Coe. No. 16,299.
M'CREERY, G. E.—See Baldwin. No. 16,240.
POOLE, D. C. E.—"Coin-freed meter mechanism." No. 16,539.
SUTHERLAND METER COMPANY, LTD.—"Coin-freed gas-meters." No. 16,654.
TURNER, E.—"Gas-producers." No. 16,554.
WILSON GAS-METERS, LTD., G.—See Poole. No. 16,539.
WILSON, J. E.—See Poole. No. 16,539.
WILSON, P. J.—"Gas or vaporized oil burner for heating." No. 16,571.

Good Pennsylvanian Gas Coal.—The quality of the Pennsylvanian coal, a shipment of 5000 tons of which arrived recently for the Birkenhead Corporation Gas-Works, has proved to be so good (the calorific power of the gas having been so greatly improved thereby), that the Gas and Water Committee have placed an order for a further 7000 tons. The price for the previous shipment was 65s. a ton; but a slightly increased rate is to be paid for the next lot. The Birkenhead authorities have considered it wise to make this forward purchase, even with the prospect of a coal settlement, because, in any case, they apprehend a coal shortage for a considerable time to come; and the Pennsylvanian product is so excellent in every way that it is felt it will be wise to have a stock in reserve.

PARLIAMENTARY INTELLIGENCE.

HOUSE OF LORDS.

Progress of Bills.

The Radcliffe and Little Lever Joint Gas Board Bill: Reported, with amendments.

The Hamilton Water and Gas Provisional Order Bill: Read the third time (according to order), and passed.

The Cardiff Gas Bill, Swansea Gas Bill, and the Rotherham Corporation Bill: Read a second time, and committed.

The Glasgow Corporation Order Confirmation Bill: Brought from the Commons; read the first time; and (pursuant to the Private Legislation Procedure [Scotland] Act, 1899) deemed to have been read a second time, and reported from the Committee.

The further Standing Orders applicable to the following Bills have been complied with: Cardiff Gas, Swansea Gas, and Rotherham Corporation.

The following Select Committee has been appointed to consider the Colne Corporation Bill, Harrogate Gas Bill, St. Helens Corporation Bill, and Wigan Corporation Bill: Lord Ribblesdale (Chairman), Lord St. John of Bletso, Lord Aberdare, Lord Loch, Lord Weston.

HOUSE OF COMMONS.

Progress of Bills.

The Glasgow Corporation Order Confirmation Bill: Considered; read the third time, and passed.

The Batley Corporation Bill: Read the third time, and passed.

The Tendring Hundred Water and Gas Bill as amended: Considered; and to be read the third time.

The Waltham and Cheshunt Gas Bill: Reported, with amendments.

The Swansea Corporation have deposited a petition against the Swansea Gas Bill.

Gas Regulation Act, 1920.

Copies were presented of drafts of Special Orders proposed to be made by the Board of Trade under Sections 10 of the Gas Regulation Act on applications by the Havant Gas Company, the Hindley Urban District Council, and the Pontypool Gas and Water Company.

Public Utility Companies (Capital Issues) Act, 1920.

Copies were presented of reports by the Board of Trade under the Act on applications by the Ackworth, Featherstone, Purston, and Sharlston Gas Company, and the Cambridge University and Town Gas Light Company.

Gas-Mantle Company's Shares.

Mr. MYERS asked the President of the Board of Trade whether his attention had been drawn to the advance in the value of the shares in the Welsbach Gas-Mantle Company, following upon the second reading of the Safeguarding of Industries Bill; and whether this fact would be taken into consideration in connection with the Government's policy on the Bill.

Mr. BALDWIN replied that he was aware that the price of the shares rose for a few days in the middle of the month; but he understood that it had since fallen to substantially the same level as that at which it stood last April.

Profiteering Act.

A copy was presented last Monday of a report on the sale and hire of gas apparatus prepared by a Sub-Committee appointed by the Standing Committee on the investigation of prices.

WALTHAM AND CHESHUNT GAS BILL.

The Bill promoted by the Waltham Abbey and Cheshunt Gas and Coke Company came before the Unopposed Bills Committee of the House of Commons on Wednesday last. Mr. HOPE, the Chairman of Ways and Means, presided.

Mr. T. SEAGAR BERRY (Messrs. Sherwood & Co., Parliamentary Agents) said the Bill was promoted by the Waltham Abbey and Cheshunt Gas and Coke Company, who, under the Bill, were changing their name to the Waltham and Cheshunt Gas Company. The main proposals were, first of all, to empower the Company to erect gas-works on lands in the urban district of Cheshunt, within the limits of supply of the Company; and, secondly, to allow them to raise further capital. With regard to gas lands, the present lands were very constricted, and the Company were working under great difficulties. They were really not able satisfactorily to meet the needs of a growing business on the present lands, and they were acquiring new ground, to which no objection was taken by anybody, for the purpose of putting up new gasholders and new works as soon as they could. With regard to the capital requirements, he handed in a statement which showed that the unexpired capital powers were £27,235, and unexpired borrowing powers £12,250; so that to-day, assuming they could issue money at par, they had power to raise £39,485. The Bill sought power to raise a further £50,000 in ordinary or preference shares, with the usual one-third borrowing power, which amounted to £16,666—a total of £66,666 new capital powers, making a total of over £106,000 altogether. The Engineer of the Company had estimated that they would have to spend £16,000 on immediate requirements, and the balance would meet expenditure in the near future. He had estimated that this balance would have to be spent during the next seven years.

Sir ERNEST MOON, K.C. (a Member of the Committee), asked how long the Company had been in existence, and the amount of capital expenditure incurred by them.

Mr. BERRY said the Company were incorporated in 1869. Since then they had spent £80,000. The capital and borrowing powers at the present time were £120,000, of which £39,485 remained.

Sir ERNEST MOON pointed out that as the Company had been carried on with an expenditure of £80,000 since 1869, the sum asked for, which would make a total of £106,000, was a large figure for seven years.

Mr. BERRY replied that it was a case in which the Company had reached to the end of their tether, and they would have to make a large capital outlay to meet their needs. They had to provide new lands, new gasholders, new plant, and new mains. The Company had discussed the question of capital with both the Hertfordshire County Council and the local Council, and had made some adjustment in the amount originally asked for. All parties had agreed the present figure, and were satisfied that it was reasonable. The Bill originally asked for £60,000 new capital, with one-third borrowing powers; but this had been reduced to £50,000. There was a report from the Home Office, added Mr. Berry; but that had been entirely met.

Mr. *Ernest J. Burton* proved the preamble of the Bill, which was ordered to be reported.

The Bill contains the usual one-third clause with regard to residuals, and the usual powers as to the laying of pipes, cutting-off supplies, &c. As to premises using electricity or other gas, the following clause is inserted:

> Where any person has for the purposes of a stand-by only a supply of gas laid on by the Company to any premises used for trade or business purposes for which he has at the same time a separate supply of electricity or gas for power or other purposes, the Company shall be entitled to charge, and receive from him in respect of the supply of gas so laid on, for each quarter of a year, and that notwithstanding that the ordinary charge for the gas supplied to such person in such quarter would amount to a lower sum, such minimum amount as may be fixed by the Company not exceeding the amount provided for by the following scale:
>
> | | |
> |---|---|
> | Where the service-pipe to such premises is of a diameter of 1 in. or less . . . . . | £1 5 0 |
> | Where the service-pipe to such premises is of a diameter exceeding 1 in. and not exceeding 1½ in. | 1 17 6 |
> | Where the service-pipe to such premises is of a diameter exceeding 1½ in. and not exceeding 2 in. | 3 15 0 |
> | Where the service-pipe to such premises is of a diameter exceeding 2 in. and not exceeding 2½ in. | 5 12 6 |
> | Where the service-pipe to such premises is of a diameter exceeding 2½ in. . . . . | 7 10 0 |
>
> Provided that in fixing the amount of such minimum charge the Company shall have regard to the probable maximum supply of gas which might at any time be required for such premises.

The usual clauses are also included for the hire or removal of fittings, supply in bulk to adjacent districts, and the variation of price according to the purpose for which the gas is used. Power is also given for the introduction of a profit-sharing scheme. The Company are enabled to make application for Provisional or other Orders under the provisions of the Electricity (Supply) Acts, 1882 to 1919, or any other Act relating to the supply of electrical energy, for authorizing the Company to supply electrical energy for public and private purposes. By any such Order the Ministry of Transport may authorize an increase in the capital and borrowing powers of the Company.

Since the Bill was originally presented, the following clause has been added for the protection of the Lea Conservancy Board:

> The following provisions for the protection of the Lea Conservancy Board (in this section called "The Board") shall, except so far as may be otherwise agreed in writing between the Board and the Company, apply and have effect—that is to say:
>
> (1) The Company shall not under the powers of the sections of this Act of which the marginal notes are "Power to Lay Pipes in Private Streets" and "Power to Lay Pipes for Ancillary Purposes," or either of those sections, break-up or interfere with any towing path, bridge, or other work vested in the Board except with their consent in writing.
>
> (2) If the Company shall at any time cause or suffer to be brought or to flow into the River Lea Navigation, or into any drain communicating therewith, any washing or other substance produced in working-up and converting on the lands mentioned in the schedule to this Act, residual products arising directly or indirectly from the manufacture of gas, or shall wilfully do any act connected with the working-up or conversion of residual products whereby the water in such Navigation shall be fouled, the Company shall forfeit and pay to the Board the sum of two hundred pounds, and shall, in addition, forfeit and pay to the Board the sum of twenty pounds for each day during which such washing or other substance shall be brought or flow as aforesaid, or the act by which such waters shall be fouled shall continue after the expiration of twenty-four hours from the time when notice thereof shall have been given to the Company by the Board. But no such forfeiture shall be recoverable unless it is sued for during the continuance of the offence, or within six months after the same shall have ceased.

RADCLIFFE AND LITTLE LEVER JOINT GAS BOARD BILL.

This Bill, which provides for the constitution of a Joint Gas Board for the supply of gas to Radcliffe, Little Lever, and other parishes, came before the Unopposed Bills Committee of the House of Lords on Tuesday of last week. The proceedings before the Unopposed Bills Committee of the House of Commons were reported in the "JOURNAL" for May 11 (p. 332), since when no material modifications have been made.

TENDRING HUNDRED WATER AND GAS BILL.

The Bill promoted by the Tendring Hundred Water-Works Company has been reported for third reading by the Unopposed Bills Committee of the House of Commons. When the Bill was considered in the House of Lords, the proceedings were reported in the "JOURNAL" (*ante*, p. 205). One or two amendments have, however, been

made between the two Houses. New provisions have been made with regard to pressure. If the declared calorific value of the gas is below 350 B.Th.U. and not below 300 B.Th.U., the minimum permissible pressure shall be 2½ in. If below 300 B.Th.U., the minimum shall be such (not being less than 3 in.) as shall be prescribed by the Gas Referees. Clause 51 provides that the prescribed testing-place shall be the existing testing-place at the existing gas-works of the Company until the new gas-works are constructed; and thereafter a testing-place at the gas-works at which they manufacture the greatest quantity of gas, "unless and until the Gas Referees shall prescribe some other testing-place or testing-places."

JOINT COMMITTEE.

RHYMNEY AND ABER VALLEYS GAS AND WATER BILL.

Before Earl of KINTORE, *Chairman*, *Lord* MONSON, *Lord* MONTEAGLE, *Marquis of* SLIGO, *Lord* ARMAGHDALE, *Mr.* HOOD, *Mr.* JOHNSTONE, *and Mr.* SAMUEL ROBERTS.

Tuesday, June 21.

This Bill deals mainly with the water undertaking of the Rhymney and Aber Valleys Gas and Water Company, but contains a number of clauses of a domestic character dealing with the gas undertaking.

Mr. FREEMAN, K.C., for the promoters, said that the Committee had already sanctioned two Bills, one of which constituted a water Board, and the other entitled them to buy the water undertaking of the Company. With regard to the gas undertaking they wanted certain matters (purely detail and domestic matters) put right, because they were an old Company and had not been put right for some time. Every clause was founded either upon the Model Clauses or else was a matter on which there had been precedent after precedent before Parliament.

Mr. *Prosser Jones* giving evidence, said the gas clauses were matters of domestic arrangement, and all founded on precedent.

Mr. CLODE, K.C. (on behalf of Caerphilly and other Urban District Councils in the Rhymney Valley), said the only objection so far as he knew on behalf of the local authorities arose on clauses 10 and 14. Clause 10 stated that: "Where any person has for the purposes of a stand-by only a supply of gas laid on by the Company to any premises for which he has at the same time a separate supply of electricity or gas for power or other purposes, the Company shall be entitled to charge and receive from him in respect of the supply of gas so laid on such minimum sum as shall be fixed by them, not exceeding 25s. for any one quarter of a year, notwithstanding that the ordinary charge for the gas actually consumed in such quarter would amount to a lower sum." Counsel asked where there were a great many small companies in the Company's area which had a separate supply of electricity.

Witness said he did not know anything of electricity.

Mr. FREEMAN said that the last words of the clause would amply protect the local authorities.

Mr. CLODE said the last words were: "Provided also that, in respect of any premises for which the whole supply of gas afforded by the Company is taken through a meter having a nominal capacity of not more than ten lights, the amount of the minimum charge shall not exceed 5s. for any one quarter of a year." That was £1 a year. Could the promoters take out the words "for which he has at the same time a separate supply of electricity?"

Mr. FREEMAN said no. They were the Company's competitors.

Mr. CLODE then referred to clause 14, which reads as follows: "Notwithstanding anything contained in any enactment to the contrary, the Company shall not be obliged to give from any main a supply of gas for any purpose other than lighting or domestic use in any case where the capacity of such main is insufficient to afford the required supply, or if and so long as any such supply would, in the opinion of the Company, interfere with the sufficiency of the gas required to be supplied by means of such main for lighting purposes or domestic use." He asked why an ordinary trader should not get a supply from the main in these circumstances.

Witness replied that it might operate to the disadvantage of the Company. They were protecting the consumer as well as themselves. They did not except lighting and other domestic purposes from the clause; and it was as much a protection to the consumer as to the Company. He instanced the case of a cinema coming into the district, and going away again the next day, such as happened in this area. If they came at the end of the street and affected the pressure to the detriment of the consumers, it would not be fair to the consumers. Neither would it be fair to the Company to ask them to relay a main where they had no guarantee of the continuity of supply.

Re-examined by Mr. FREEMAN, witness said that with regard to clause 10, at the present time there was no minimum. The minimum proposed was £1 per year if under ten lights, and £5 a year if over, which was fair and reasonable.

Mr. *John Davis* (a member of the Caerphilly Council) said that the Council thought clause 10 would be detrimental to the consumer, because the charges were too high. There were many who had more than ten lights and had already electric light; and it would be much against them to pay 25s. per quarter. With regard to clause 14, the Council's view was that it deprived the consumers of their statutory rights to ask for a supply.

Asked by Mr. FREEMAN what he thought the charges in clause 10 ought to be, witness did not reply. Counsel also reiterated the fact that the clause was founded on precedent.

The CHAIRMAN announced that the Committee were of the opinion that the Bill should proceed.

The remaining clauses in the Bill were the usual ones providing for notice to be given by the consumer before removing, period of error in defective meters, variation of price according to the purpose for which gas is supplied, cutting-off supplies and removing fittings, and the placing of pipes between mains and meters. A clause for the protection of railway companies is also included, which provides that pipes laid on the premises of any railway company between the mains and the meter must not be less than 2 in. internal diameter. With regard to capital, the Company have power to borrow on mortgage of the undertaking, in addition to sums already borrowed, a further £47,087 5s.; a sum not exceeding, in respect of the additional capital authorized by the Company's Act of 1914, £9585 10s.; and from time to time any sums up to one-half the amount of capital raised under the 1914 Act as amended by this Act. The last-mentioned powers are subject to it being proved to a Justice of the Peace that the whole of the amounts payable in respect of the stock or shares at the time issued, together with the premium (if any) realized on the sale thereof, have been fully paid-up. It should be pointed out that the Company were authorized to raise £280,000 of capital and £70,000 of loans under their Act of 1898, and £150,000 of capital, *plus* one-third of the additional capital issued under the Act of 1914. The whole of the share capital authorized in 1898 has been raised, as well as £38,280 of that authorized in 1914. Debenture stock to the amount of £54,230 has also been issued under the 1898 Act; but no money has been borrowed under the powers of the 1914 Act. The dividend on the preference shares issued under the Act of 1914 was limited to 6 p.ct., but that is revoked in the Bill, and power is given to issue future preference capital at a dividend to be determined by the Company.

MISCELLANEOUS NEWS.

APPOINTMENT, QUALIFICATIONS, AND DUTIES OF GAS EXAMINERS.

Memorandum by the Gas Referees under the Gas Regulation Act, Drawn up for the Information of Local Authorities and Quarter Sessions.

The Gas Regulation Act, 1920, provides that the charges made by gas undertakings for the public supply of gas shall be based on its heating or calorific value, and that official tests shall be made by gas examiners for the purpose of ascertaining the calorific value, purity, and pressure of the gas. In the event of the official testings showing that the average calorific value of the gas in any quarter is less than it should be, a proportion of the revenue of the gas undertaking has to be applied to a reduction in the price of gas in a subsequent quarter.

Under the Gas Regulation Act, 1920, the gas examiners provided for by the Act are appointed by local authorities or quarter sessions. The sections or subsections relating to the appointment, qualifications, and duties of gas examiners, and the provision of testing-places and apparatus for use by them, are as follows:

4.—(3) The local authority may, unless they are themselves the undertakers, appoint a competent and impartial person to be a gas examiner, and subject to the prescription of the Gas Referees to test the gas and the pressure at which the gas is supplied:

Provided that—

(*a*) for the purposes of this section, a gas examiner may be appointed to act on behalf of any number of local authorities, and the local authorities may enter into such arrangements as they think fit in regard to the joint appointment and employment of such gas examiner; and

(*b*) any county council may, if they think fit, with the consent of any other local authority within the county, appoint a gas examiner, who shall have the same powers as if he were appointed by that local authority.

(4) Where no gas examiner is appointed by the local authority, or where the testing of gas is imperfectly attended to, quarter sessions, on the application of not less than five consumers, may appoint a competent and impartial person to act as gas examiner, who shall have the same powers and perform the same duties as if he were appointed by the local authority, and the remuneration and expenses of the gas examiner up to an amount approved by quarter sessions shall be paid by the local authority.

5.—(1) The Gas Referees shall prescribe—

(*a*) the places and times at which and the apparatus and method by which tests, whether continuous or intermittent, shall be made to ascertain whether any undertakers with respect to whom an order has been made under this Act are supplying gas in accordance with their obligations; and

(*b*) the method by which any such apparatus shall be verified; and

(*c*) the time and form of the reports to be made by the gas examiner to the Gas Referees and the local authority or quarter sessions by whom he is appointed, and to the undertakers, and the means by which the results of the tests shall be made available to the public:

Provided that, unless otherwise agreed between the undertakers and the authority by whom the gas examiner is appointed, any testing-place provided by the undertakers in pursuance of any Special or other Act of Parliament relating to the undertaking shall be deemed to be a prescribed testing-place under this section; but the Gas Referees may, if they think fit, prescribe any additional testing-place in respect of that undertaking.

(3) Any undertakers with respect to whom an Order has been made under this Act shall provide and maintain to the satisfaction of the Referees the prescribed testing-places and apparatus, and shall give any gas examiner access to any testing-place for the proper execution of his duty.

18.—For the purposes of this Act—

The expression "local authority" means the common council of the City of London and any county, county borough, or urban district council, and in relation to any gas undertaking means any such local authority the whole or any part of whose area is within or partly within the limits of supply of the undertakers.

The expression "gas undertakers" or "undertakers" means any local authority, company, body, or person authorized to supply gas by any Act of Parliament or any Order having the force of an Act of Parliament.

The expression "quarter sessions" in relation to any undertaking means the court of quarter sessions for the county, division, or place in which the gas-works of the undertaking are situate.

20.—The expenses of a local authority under this Act shall be defrayed, in the case of the common council of the City of London out of the general rate, in the case of a county council as payments for special county purposes made in respect of the parishes which are wholly or partly within the limits of supply of any gas undertakers in respect of which the county council have power to appoint a gas examiner, and in the case of other councils as expenses incurred in the administration of the Public Health Acts, 1875 to 1908.

As regards "competence" of gas examiners, the Gas Referees consider that it is important that a gas examiner should have a sufficient knowledge of physics and chemistry to enable him to understand thoroughly the tests to be applied to the gas. It is also important that he should be a person accustomed to making quantitative measurements, the accuracy of which he is prepared to sustain under cross-examination. A person of good professional standing, as an analyst or engineer, and with experience of the physics and chemistry of gas, would be suitable. In any case, the qualification of the gas examiner should be such as to inspire the confidence of the public and of the management of gas undertakings.

As regards "impartiality," it is obviously undesirable that the gas examiner should be in the employment of the gas undertaking, or should have any financial interest in it; and that when the local authority owns the undertaking, he should not be an employee of the authority.

When a gas examiner is appointed, a deputy similarly qualified should, where practicable, also be appointed to act in his temporary absence.

The time which the gas examiner will have to give to official gas testings depends on the prescriptions of the Gas Referees, which will vary with the advance in the design and construction of testing apparatus and with local conditions of gas supply. The following figures, though only rough approximations, may serve as a guide to the time which a gas examiner is likely to have to devote to his duties.

He will be required to visit the testing-place at intervals of time, which in most cases need not be strictly equal. The time needed for each visit will probably be about two hours. The minimum number of visits will probably be:

For gas undertakings supplying:

More than 1000 million c.ft. a year: One each day (for the present).

Less than 1000 million and more than 250 million c.ft. a year: One each week.

Less than 250 million and not more than 100 million c.ft. a year: One each fortnight.

Less than 100 million and more than 50 million c.ft. a year: One each month.

Less than 50 million c.ft. a year: One each quarter (as a minimum).

[The Board of Trade "Annual Returns of Gas Undertakings," of which the last issues are the Stationery Office Publications Cmd. 1021 and 1210, show the quantities of gas supplied by all authorized gas undertakings in the United Kingdom.]

Where the undertaking has more than one works, or any detached gasholder station, the Gas Referees will usually prescribe more than one testing-place. In that event, or in cases where more than one testing-place prescribed under previous enactments are retained, provision must be made for the attendance of a gas examiner at each testing-place.

Needless duplication of testing-places and overlapping of the work of gas examiners will be avoided, and economy and efficiency in gas testing will be promoted, if local authorities enter into arrangements for the joint appointment and employment of gas examiners, and, in suitable cases, arrange for the appointment to be made by the county council. When formulating their prescriptions for particular undertakings and areas, the Gas Referees will endeavour to provide for the full advantages of any such arrangements being reaped.

GAS REGULATION ACT APPLICATIONS.

The following further notices have appeared in the "London Gazette" of applications by gas undertakings to the Board of Trade for Orders under the Gas Regulation Act.

Brecon Gas Company.

The standard price now authorized in respect of the supply of gas by the undertakers is 4s. 7d. per 1000 c.ft., subject to a discount at the rate of 5d. per 1000 c.ft. upon payment within one month after the termination of the quarter in which such supply was furnished. The price they have asked the Board of Trade to substitute for this is 2s. per therm, subject to a discount at the rate of 1d. per therm upon payment within one month.

Worksop Gas Company.

The standard price now authorized in respect of the supply of gas by the undertakers is 3s. 8d. per 1000 c.ft.; and the price they have asked the Board of Trade to substitute for this is 1s. 6d. per therm.

SPECIAL ORDER.

Aylesbury Gas Company.

Application has been made by the Company to the Board of Trade for a Special Order to empower them to purchase the undertaking of the Wendover Gas Syndicate, Ltd.; to acquire additional lands; to raise further capital; to institute profit-sharing; to extend their limits of supply; to make further provision as to the price of gas, &c.

DECLARATIONS OF CALORIFIC POWER.

East Cowes Gas Company.—450 B.Th U. (June 22.)
East Hull Gas Company.—450 B.Th.U. (June 22)
Frodsham Gas and Water Company.—470 B.Th.U. (June 24.)
Grantham Gas Company.—400 B.Th.U. (June 23.)
Guildford Gas Company.—450 B.Th.U. (July 1.)
Harpenden District Gas Company.—450 B.Th.U. (June 27.)
Harrow and Stanmore Gas Company.—450 B.Th.U. (June 25.)
Ilford Gas Company.—450 B.Th.U. (June 25.)
Prescot Gas Company.—420 B.Th.U. (July 1.)
Rochester, Chatham, and Gillingham Gas Company.—475 B.Th.U. (June 25.)
Rugby Gas Company.—480 B.Th.U. (June 27.)
Walker and Wallsend Union Gas Company.—500 B.Th.U. (June 27.)
Woolton Gas Company.—470 B.Th.U. (June 24.)

GAS REGULATION ACT ORDERS.

The Director of Gas Administration has forwarded copies of the following further Orders made under section 1 of the Gas Regulation Act. The parts applying specially to the Companies named, and the dates of coming into operation, are noted.

East Cowes Gas Company.

As from the declared date, the maximum price in respect of gas supplied by the undertakers shall be 18d. per therm. (June 20.)

Guildford Gas Light and Coke Company.

After the declared date (*a*) the standard price in respect of gas supplied by the undertakers shall be 16·4d. per therm; (*b*) the price of 15·2d. per therm shall be substituted for the price of 3s. per 1000 c.ft. mentioned in the second proviso to paragraph (1) of section 8 (price of gas—sliding-scale) of the Guildford Gas Order, 1915; (*c*) the sums of 1·2d. per therm and 2·4d. per therm respectively shall be substituted for the sums of 6d. and 1s. per 1000 c.ft. mentioned in paragraph (2) of the said section 8.

For the purpose of ascertaining the authorized rate of dividend for the half year in which the declared date occurs, the price charged per 1000 c.ft. during that part of the half year (if any) before the declared date shall be rendered into the equivalent price per therm by dividing it by four-and-one-half.

Prepayment meter clauses are included. (June 23.)

Highbridge Gas Company, Ltd.

After the declared date, the standard price in respect of gas supplied by the undertakers shall be 17·4d. per therm.

For the purpose of ascertaining the authorized rate of dividend for the year in which the declared date occurs, the price charged per 1000 c.ft. during that part of the year (if any) before the declared date shall be rendered into the equivalent price per therm by dividing it by four-and-one-half.

Prepayment meter clauses are included. (June 18.)

Kidderminster Gas Company.

As from the declared date, the maximum price in respect of gas supplied by the undertakers shall be 16d. per therm.

Prepayment meter clauses are included. (June 21.)

Ramsbottom Gas Company.

As from the declared date, the maximum price in respect of gas supplied by the undertakers shall be 18d. per therm. (June 22.)

Walker and Wallsend Union Gas Company.

After the declared date, the standard price in respect of gas supplied by the undertakers shall be 14 8d. per therm.

For the purpose of ascertaining the authorized rate of dividend for the year in which the declared date occurs, the price charged per 1000 c.ft. during that part of the year (if any) before the declared date shall be rendered into the equivalent price per therm by dividing it by five. (June 22.)

Whitworth Vale Gas Company.

As from the declared date, the maximum price in respect of gas supplied by the undertakers shall be 20·8d. per therm. (June 21.)

Further Coke Restrictions in the Metropolis.—The depletion of stocks of coke has made it necessary to regulate still more the supplies in the Metropolitan fuel area. Permits for further supplies of coke are to be limited to consumers on the priority list, and permits to acquire more than 5 tons a week are not to be granted by local authorities in the Metropolitan area without reference to the Metropolitan Emergency Coal Committee. Gas undertakings, merchants, and factors have been requested to limit deliveries to private houses, boarding houses, blocks of flats, and hotels to quantities not exceeding 10 cwt. per week, unless authority for a larger amount has been given by the Committee. Arrangements under which limited quantities of coke have been allowed to laundries are now cancelled; but permits to acquire a quantity of coke breeze not exceeding one-third of the normal supplies of fuel may be issued to laundries by the local authorities. These permits are valid for one week only.

BOMBAY GAS COMPANY, LTD.

The Ordinary General Meeting of the Company was held last Thursday, at the London offices, Moorgate Street Chambers, E.C.—Mr. H. E. JONES in the chair.

The SECRETARY (Mr. A. Dickson, jun.) read the notice calling the meeting and the report of the Auditors; and the Directors' report and the accounts were taken as read.

THE AUDITORSHIP.

The CHAIRMAN, in moving the adoption of the Directors' report and the accounts, said he was very sorry to have to meet the shareholders in times which were specially topsy-turvy for everybody, as well as for gas companies, because they all wanted coal, and could not get it. He regretted that his first duty must be to remind the shareholders of the death of their late Auditor (Mr. Ernest Drew, F.C.A.); and he had no doubt they would join with the Directors in a vote of sympathy with his relatives. He was for many years Auditor of the Company; and he had a reputation as a gas auditor which was almost unrivalled. Mr. Drew was one of his (the Chairman's) personal and oldest friends; and Mr. Lass, who was at one time head of the firm, was Secretary for a number of years of one of the companies of which he (the Chairman) was Engineer, but that was away in the "dark ages." The Board had been able to get one of the partners of the firm, of which Mr. Drew was the head, to continue to act temporarily as Auditor, subject to his re-election at this meeting. One of the duties of the shareholders would, therefore, be to confirm the appointment of Mr. Alfred Morland, F.C.A., as Auditor, in company with the re-election of Mr. Spencer Gore Browne, who was associated in the auditorship with Mr. Drew.

ELEVEN WEEKS' STRIKE OF THE COMPANY'S MEN.

He had already said something about the times being topsy-turvy, but they might congratulate themselves—he did sincerely congratulate the shareholders—on being able, notwithstanding the heavy fluctuations in the prices of materials and labour, to show the financial state of affairs which they did in their report and accounts. The fluctuations in the cost of labour and materials had very heavily burdened gas companies in this country and in Europe generally; and he might add South America as well, for he was connected with a Company operating there. Both in his professional capacity and as a Director, he knew what these burdens had meant for gas undertakings in England; and these undertakings had been unable, practically speaking, to get as much as a lump of British coal for nearly three months, owing to the suspension of work at the mines. All these conditions, of course, affected places even as remote as Bombay. At the same time they had had their own special troubles and grievances along with most of the industries of Bombay. The Company had had their men out on strike from Oct. 1 to Dec. 20. When he told the shareholders how unreasonable this suspension of work was, and how it was purely the work of professional agitators, they would wonder why there had been a strike at all. Their Manager, Mr. A. R. Burch, who was present on this occasion, had before the strike no knowledge of what was going to take place all round them in connection with labour in Bombay. He had already given considerable privileges to the Company's men; and therefore he was quite staggered when, instead of the men going direct to him if they wanted something more, he had a visit from a smooth-tongued, well-spoken, educated gentleman, who professed to be a solicitor in the district, and had been specially employed by the men to advocate a remedy for their supposed grievances. Mr. Burch had reported to the Board that he had had the fullest discussion with his own men, and that they went away apparently quite contented. Therefore he was surprised when he had this visit from a stranger on behalf of the men. But when he went outside the works he found the tramways, the post office, and the electric lighting company were all in the same boat. The same specious gentleman had been busy at work in all directions. However, Mr. Burch received from other employers of labour, and many other people interested in the success of the city of Bombay, every encouragement to resist the further aggressions suggested by this gentleman. After the long strike—a strike extending over a period of eleven weeks—their men came back again; and they practically got nothing more than Mr. Burch told them they could have before they struck at all. Notwithstanding the long period of the strike, the men only succeeded in suspending the actual supply of gas for five days, though for something like three weeks they prevented the public lamps in the streets being lighted. The gas was there, the lamplighters were there, but the malcontents threatened to break the heads of the latter if they lighted the lamps. They intimidated these men, who were of a class not of a sufficiently sturdy character to resist the pressure put upon them. Thus for the time being the lamps could not be lighted.

THE STRIKE, BUT STILL AN INCREASE OF BUSINESS.

Although they suffered in this way, there was not a very large diminution in the sale of gas, because the gas they were able to make was eagerly taken by the inhabitants. On the whole, they had succeeded in getting, instead of the usual 7 p.ct. increase in the sale of gas, an increase of 2·7 p.ct., in a city which had had a plague of strikes in all directions. It was rather remarkable in his view that, in the circumstances, they did so well as this. It showed there was still the same progress, the same advantage for them in the future. Even under this difficulty of the strike, they maintained progress, although a diminished one. He believed that, had they not been so unfortunate in having the strike, they would have shown much better progress than they did that day, because during that period, working with raw hands under great stress and pressure, it was not possible to look so well after the secondary products, or to get the same amount of coke and other things to sell. The whole of their processes were, of course, being worked with less workmanlike skill, and therefore with less advantage to the Company. But this outcome was unavoidable. The accounts, when they came to look into them, were nothing like what they had hoped to put before the shareholders; but fortunately the results were sufficient to enable the Directors to recommend the dividend the shareholders were no doubt looking for and expecting. In this respect, meeting at this time and within a few weeks of the meetings of big gas companies in England, the shareholders would be comparing their financial position; and he was sure that the comparison would give them much satisfaction and consolation. The suspension of the coal supply to the gas companies in London and England generally had practically knocked the bottom out of their profits for the past half year. He knew so much about the gas business in this country that he was very confident that must be the result.

A LOYAL STAFF, AND COMPULSORY MECHANICAL OPERATION.

In regard to the strike of their own workmen, the Company were lucky in one thing. They were lucky in their staff. They had succeeded in carrying the flag throughout that period, and they would continue to keep it flying. This was all to the credit of Mr. Burch, his staff, and those who worked under them—loyally, manfully, and well, and to whom he (the Chairman) would take the opportunity presently of asking the shareholders to record their recognition. The strike had resulted in one thing. The wages as they were at present would probably be modified, because, as the shareholders would understand, there was always the mechanical engineer, who entered largely into the labour problem. All through the world's history, it had been found that the moment the producing cost of anything was violently disturbed, the mechanical engineer came along, and devised means by which they could save on production; and so production was obtained at less cost.

THE POSITION OF THE CAPITAL ACCOUNT.

This brought him to the accounts; and he should like to say that they were suffering from great financial and monetary difficulties. They were not suffering like some of the English companies had suffered under the sliding-scale, with their dividends reduced by half or by one-third of what they were accustomed to receive in happier times. Even in England money was very tight; and the difficulty of all gas undertakings to-day was to find the extra money. In their own case they had been able to do this largely out of their own resources, which, fortunately for the Company, were uninvested. If they had had them invested in 3 or 4 p.ct. securities while the bank was asking 6 or 7 p.ct., they would have been making a loss over all that money. Like most of the prosperous companies in this kingdom, they had seen the wisdom of merging their various funds in the capital of the Company. They borrowed from these funds until the time came when they could raise capital easily, and then they paid the money back, and restored the funds. If the shareholders looked at the capital account, they would see that they spent last year the moderate sum of £14,653. They had to lay some new and additional mains. He hoped that every yard of them had been necessary. The Directors strongly urged on the local management that they could not afford to lay more mains than were absolutely necessary, because these things were at such an enormous price to-day compared with what they were under normal conditions. But in accordance with the contract arrangements with the municipal authorities, when the latter wanted to light and develop a street, the Company had to light the lamps there. Under this condition, they had had to lay mains which, from a mere commercial point of view, they would rather have avoided; seeing that, partly due to this, the capital had gone up by £14,653, or nearly 5 p.ct., while the sale of gas had only increased by about 2¾ p.ct. If they went on in this way, it would certainly bring them to grief, though, of course, they would have had a larger percentage of increase for the capital spent had it not been for the long strike of their men.

HOUSING THE STAFF.

They were faced with the difficulty of housing their European staff. The chawls (cottages) round the works in the mean part of the City were not very healthy; and they could not ask Europeans, with their present ideas and tastes, to go into such habitations as those. They therefore secured a piece of land some distance away from the works in the town, and in a good position; and there they had built substantial premises in flats, which was carried out most economically. It, however, accounted for rather over £6000; and it was not what they would call remunerative capital. But it was accommodation for their staff; and the shareholders would recognize their obligation to the staff to see that they were housed properly and well.

CHANGE AND DEVELOPMENT IN THE GAS BUSINESS.

Then they had a small item of £2173 for new and additional meters. A meter to-day cost four times what it used to cost. But they had to keep their business going; and it was a great feather in Mr. Burch's cap that, since he had been in Bombay, he had developed the lighting very considerably, particularly among private people. This had increased the demand for meters and services. When he, the Chairman, first sat at the Board, the public lighting was practically the staple business of the Company. It then overbalanced the private lighting by two to one; but now the private lighting overbalanced the public lighting by more than two to one. All this development had taken place during Mr. Burch's *régime;* and this would assist in reconciling the shareholders to the fact that they were now a little short of capital. As would be seen by the capital account, the "balance to the balance-sheet" was on the wrong side by £49,535. It was £34,883 last year; and the £14,653 had brought it up to £49,535. Financially it had been a very bad time. The peace had been worse than the war. During the war, they could not get capital; and now the peace had come, they could not obtain it. In the war, the bankers would lend them money; now they would not do so at any price. This was the contingency the shareholders had to face. How would they face it? It was not only in respect of extensions of plant and buildings that they needed capital, but they required liquid capital for other things that were necessary to the maintenance of the undertaking. The shareholders would see that all their stocks and stores now required more capital. The stocks of coal, coke, breeze, and tar, and sundry stores in the balance-sheet represented a figure which was nearly £30,000 in excess of what it was last year. All their stores were much dearer. Then as to the accounts due to the Company. These were up by £8564. Therefore, on the total, they wanted nearly £30,000 more in fluid capital to carry on the works; and they had

overspent the ordinary capital by £49,535. Putting these two figures together, it would be found that they represented nearly £80,000, which they had to borrow from their bankers and from their various securities. How were they going to get that money to-day when the bankers wanted 7½ p.ct.? One of the most prosperous gas undertakings in this country—the Plymouth and Stonehouse Gas Company—who were supplying gas very cheaply, and had a very low capital, and everything in their favour, were now issuing £69,835 of redeemable debenture stock at 7½ p.ct. Gas companies had been accustomed to borrow money at 4 to 4½ p.ct. Mr. Richards was not present on this occasion; but, if he had been there, he would have been able to give eloquent testimony to the fact that the whole financial position had been reversed. If a company went badly to work, and raised a lot of money at a high rate of interest, and then things went down in the course of a few years, they would have in perpetuity to saddle themselves with capital at a rate which was abnormal. It would be a burden for all the future. What was the remedy? Their Deputy-Chairman (Mr. W. G. Bradshaw), who was perhaps more skilled in these matters than most men in the City, had been exercising his brain over it; and he had rather staggered his colleagues by what he told them as to what the Stock Exchange said must be the effect if they went outside to raise money.

PRIVATE LOANS FROM THE SHAREHOLDERS.

But he (the Chairman) had often wondered in such a contingency whether they could make a system of contributions on good security by way of a private loan from the shareholders themselves. He was strong upon this point. He had a great objection to a speculator on the Stock Exchange getting 6 or 7 p.ct. for money lent, when everybody else was getting only 4 p.ct. for the money they had lent. If any such issue of loan could be taken up by their own shareholders, he did not think, on the balance of things, it would matter very much. They were trading in hard times—in difficult financial times. Let their own shareholders get some of the benefit of trading in these times; and if there was to be any pull by abnormal prices to-day for money accommodation, let them take it themselves. Unfortunately, there was not a large meeting of the shareholders; but he hoped that what he was saying now would go home to them. In every board-room of companies with which he was connected, he said: "Do not sell shares to anybody at the present market price." The present market price would rob them, because of the temporary depression, of what should be theirs in the good future that the gas industry had before it. Never had gas been so dear; never owing to the hardships of strikes and difficulties had gas been so bad in quality; never had it been so eagerly sought after. A company of his in the south-west of London used previously to let out stoves, meters, and fittings. To-day they could not do it. They said to the people: "We cannot find the capital now; and so you cannot have penny-in-the-slot meters for the time being, though you offer to pay the rent for them." All through the war and peace time, however, the weekly returns of that company showed that the people were still coming with avidity for stoves with which to burn gas. Even during the strike, although the company had cut down the supply at every possible point, the consumers were using about 2 p.ct. more gas than they did when there was no dearth of coal. The fact was it was a question of transport. When once gas was made at the works, it almost transported itself to houses and works where it was wanted. If a householder or a factory owner wanted coal he had to buy it; and it had to be conveyed by railway wagons and horses and carts; and if the consumer lived two or three miles from a station, he was done. It was this potentiality of cheap fuel distribution in the form of gas that was of so much value. He knew all about gas coke. But there was the same embargo on coke as there was on coal. It had to be distributed by labour and horses and carts or mechanical traction; while gas "slid," so to speak, through pipes to the very place where it was wanted for consumption, from the storage at the gas-works. There was nothing that he could see in the future that was going to disturb the supremacy of gas over electric light or electric heating. He had studied the question; and he could not find a figure small enough to represent the cost of transporting gas through a mile of main, when once the main was laid of proper calibre. The founders of the Bombay Gas Company laid a splendid system of canalization; and to-day it came into play, and was extremely good for the Company. Still, there were considerable main extensions due in Bombay.

A LITTLE DELAY IN DIVIDEND PAYMENT.

The Directors were going to ask the shareholders to pass a resolution declaring a 4 p.ct. dividend, making 8 p.ct. for the year, which would leave nominally £25,000 to be carried forward to the current year. But, unfortunately, the Directors could not pay it to the shareholders that day. They would have to ask them to wait a short time, until they could raise the money. The Company had earned the money; and the fact why the shareholders were not getting the dividend at once was that the available funds were short.

NO LARGE INCREASE ON COST OF COAL—WAGES CONSIDERABLY HIGHER.

If he dealt with the revenue account, and the manufacture and distribution of the gas, it would only weary the shareholders. There were a great number of features in the accounts; but they were very trite. Coal, fortunately owing to the foresight of the local Manager, backed up by the Board, did not show a very large increase, as it was now customary to see in European companies; but wages were considerably higher. The item was likely to remain large. As wages entered into repairs and maintenance of the works and the distribution system, he was afraid they would probably see a considerable increase there for some years to come. The drift of the day was that labour sought a higher recompense, easier circumstances, and more indulgence, such as their grandfathers and fathers never thought of. However, he was confidently of opinion that anyone administering gas companies could meet a reasonable state of advance; and the consumers would help them to meet it, without any disadvantage or permanent injury to the capital invested in the concern.

The Deputy-Chairman (Mr. W. G. Bradshaw, C.B.E.) seconded the motion.

The Fall in Exchange.

Mr. Samuel Spencer asked the Chairman if he could give the shareholders some information as to the exchange.

The Chairman said that was a question he had particularly marked; and he was sorry that he had omitted to deal with it. Exchange had now gone against them. If they looked at the net revenue account, they would see exchange credited with £11,405, or £2654 more; and if they had not had this, the dividend would have had to be diminished. It had not only fallen, but certainly it was not going up in the current year—in fact, he was afraid it was likely to be reduced. The Secretary in a note on the subject said: "The Indian exchange in the early part of 1920 rose as high as 2s. 10d. per rupee. The average rate for remittances during the year was 2s. 1½d.; but by the end of the year the rate had fallen to 1s. 6d. It was now as low as 1s. 3½d. The Company benefited to the extent of £11,405; but the subsequent fall in exchange would have an adverse effect during the current year, unless there was an early improvement in the export trade of India, leading to a justification of the optimistic forecast of the Finance Member of the Government of India in introducing the budget, in which he estimated the average exchange during the current financial year at 1s. 8d."

The Deputy-Chairman: It is only 1s. 3½d. now.

Mr. Spencer congratulated the Chairman upon his interesting explanatory speech. Taking the balance-sheet altogether, he did not think there was much upon which to comment, because he saw the carry-forward would be £61 better than last year, and was equal to the amount of dividend paid in the year, and something over. Considering the strike and other factors in the situation, he thought the shareholders ought to be very satisfied. As for the delay in the payment of the dividend, they would only receive it with the greater pleasure. The Chairman's remarks would be circulated among the whole of the shareholders; and they would show them the great potentiality there was in the gas business. As soon as the miners got back to work, this would again set the ball rolling in the industries of the country, though to get back to normal conditions would take time. He congratulated the Directors and the officers upon getting on so well in view of the strike. The results from Bombay were excellent.

The motion was unanimously carried.

The Dividend.

The Chairman proposed—"That a final dividend for the year ended Dec. 31, 1920, of 4 p.ct. (less income-tax at the rate of 3s. 8½d. in the pound) be now declared, making with the interim dividend of 4 p.ct. a dividend of 8 p.ct. for the year, and that such final dividend be paid when, in the discretion of the Directors, the finances permit."

The Deputy-Chairman seconded the motion, which was unanimously passed.

Re-elections.

On the motion of the Chairman, seconded by Mr. Louis Penny, the retiring Directors (Mr. W. G. Bradshaw and Mr. Charles Hunt) were re-elected.

Proposed by Mr. Spencer, and seconded by Mr. Aschwarden, Mr. Spencer Gore Browne and Mr. Alfred Morland, F.C.A., were re-appointed Auditors.

Votes of Thanks.

The Chairman said he had now to ask the shareholders to pass a vote of thanks to Mr. Burch and his staff, as well as to the Secretary (Mr. Dickson) and his staff. Anybody who had been through a strike of gasworkers (he himself had been through three during his sixty years' "wanderings in the wilderness") would know what it was to find their more humble colleagues, whom they were accustomed to meet with a smiling nod, suddenly become irresponsive souls, sulking, and refusing to handle their tools. Those who had experienced this would be able to realize what it was to a man in Mr. Burch's position, to his assistant (Mr. Lane), his chief man on the works (Mr. Sherret), and all the European staff; but those who had not had similar experience could hardly realize what a shock it was if one had a nervous system. The blow was enormous. The demand for resourcefulness and personal effort were great. Many gentlemen in their service took off their coats, rolled up their sleeves, and went straight from office to retort-house. That was the kind of loyalty and fidelity which was altogether outside the ordinary conditions of contract for service; and when it came it revealed a sentiment in the human mind which was divine. It was above all praise. Patriotism and loyalty, whether to King or employer, were sentiments which lifted men above the beasts of the field. Their staff and other loyal men went to take the places of the malcontents; and they did this to keep the city free and safe from rapine and lawlessness, and in a condition of comfort, because even food could not be cooked to-day without the service of gas. They worked for long hours in a high climatic temperature and in the high temperature of the retort-house, in which there was no machinery. But under these exhausting conditions, except for five days, they kept the flag flying. The Board had given the staff monetary consideration; but it was quite slender and poor compared with their efforts and their zeal. But beyond this, he wanted to send them the thanks of the shareholders in recognition of their extra services—the unusual services—they rendered during the strike, and also for bringing before them such a statement of accounts, which, as Mr. Spencer had wisely and soundly pointed out, would not have been a discredit to the Company even though they had had no strike at all. Mr. Burch, who was present, had given them many years of good and fruitful service; and the staff and heads of the departments worked well. They deserved the best the shareholders could give them. As to the Secretary and his staff, the accounts were kept in a capable, complete, and compendious way, and were always prompt. He did not know of any company in which they got the figures and returns quicker or more completely analyzed than they did at the hands of Mr. Dickson.

The Deputy-Chairman seconded the motion, which was enthusiastically carried.

Mr. Spencer said they were all delighted to see Mr. Burch present, and in such good fettle after his ten years in India.

AS OPTIMISTIC AS EVER.

Mr. BURCH thanked the Chairman very much for his kind remarks, and for the way the shareholders had received them. It was true that his staff and himself went through a very hot time (in two senses of the word) during the strike. He was sure that every European and a great many of the Indians—especially the Goanese—did their part most manfully; and they saw the thing through. In 1911, 1914, and 1918, he (Mr. Burch) had expressed himself as an optimist in regard to the future of the Company. He was as optimistic as ever. The Company's future was a magnificent one, in particular for the sale of gas for purposes other than lighting, which was also good. He looked forward to the future with as much confidence as ever.

On the proposition of Mr. SPENCER, seconded by Mr. ASCHWARDEN, a cordial vote of thanks was passed to the Chairman and Directors.

The CHAIRMAN expressed his acknowledgments on behalf of himself and his colleagues. He was very much obliged to the shareholders, because it had been rather a painful and a stiff year for the Directors.

SOUTH AFRICAN LIGHTING ASSOCIATION, LTD.

Poor Colonial Coal, but Better Found.—Increases in Gas Consumption.

The Ordinary General Meeting of the Association was held last Wednesday, at the London Offices, No. 90, Cannon Street, E.C.—The Rt. Hon. Sir DANIEL F. GODDARD in the chair.

The SECRETARY (Mr. William Cash, jun.) read the notice calling the meeting; and the Directors' report and the accounts were taken as read.

The CHAIRMAN moved that the Directors' report and the accounts be approved and adopted. In doing so, he said he was sorry that the report showed that the past year had not been so good as the previous one. The profits on the working were some £1131 less than in 1919. This mainly arose at Port Elizabeth; and to a small extent at Grahamstown. The real fact was that, although their works were so far away from this country, they had not been exempt from the troubles with which gas companies at home had had to contend in many ways. For instance, the shareholders knew that for many years the Company had used none but Colonial coal for gas making; and this had proved very satisfactory and economical. But this last year they had had great difficulty. First of all, the price had gone up very materially. At Port Elizabeth, the coal bill had risen by £3665. He did not know that they would have objected very much to this, but unfortunately there had not only been a rise in price, but there had been great difficulty in getting coal delivered, on account of railway troubles, and the quality had gone down very considerably. The make of gas had been very low compared with what they were accustomed to—only just over 9000 c.ft. per ton, which was almost entirely due to the quality of the coal. They had been in the habit of using coal from a colliery called Burnside; and this had in the past proved to be excellent coal. But the demands upon the colliery had been so great that it had not been able to supply them with the usual class of coal. What they had delivered was very inferior. He was, however, able to make this hopeful remark, that the coal had much improved—in fact, what they were getting now was very good. The Company would probably have to change-over to another colliery. Other collieries had been opened; and they had discovered a coal which the Directors and their Engineer thought was quite equal to the Burnside. They therefore hoped for much better results this year. Another source of trouble was that during the war it was quite impossible to do the necessary repairs to the carbonizing plant. They could not get shipping; they could not get delivery of the material; and they could not get men. So the carbonizing plant got gradually into a bad state of repair; and this partly accounted for the poor make of gas. He was happy to say they had had men working there now for quite a long time. The whole of the retort plant had been renewed thoroughly; and they anticipated soon getting their former good results. Then, of course, the cost of labour had gone up very substantially. The cost of labour and materials at Port Elizabeth had increased by £800 in the year. This, of course, they had anticipated; but whether they would share in any reduced rate of wages which was hoped for in this country, they did not yet know. Another source of loss had been in regard to tar. They were getting a very high price for tar. But now some people had begun to import it into the Colony; and the result was that the price had fallen, and they had received something like £622 less than in the previous year. They were still making a very good price for it, but not so good as it was. These were all bad figures, but happily there were good figures on the other side. The sales of gas had increased at both places. At Port Elizabeth, the sales had advanced by 11·8 p.ct. This was a very material increase; and he might say it was continuing this year. Every report they received showed that the increase was being maintained. The consumption per consumer had also increased by nearly 2000 c.ft. This larger sale of gas helped them a good deal to meet the losses incurred. The item of leakage had been a trouble to them for many years. It still troubled them. It was a high figure—much higher than it ought to be; but they were taking every possible step to try to reduce it. The explanations of this were rather difficult; but the fact was in Port Elizabeth there had been large excavations in connection with the sewerage works. Mains had often been broken; and there had been a large leakage before they had time to know of the breakages, and to repair them. This might account for some of the leakage. He did not, however, think that it was all due to this; but he believed that some of it might be caused by the gas being measured at the works at a temperature higher than that at which it was delivered to the consumers. This might account for a little of it. At Grahamstown the coal had cost them £1098 more than in 1919; and the make had gone down from 9670 c.ft. to 9120 c.ft. This was due partly to the bad quality of the coal, and partly to the bad state of the retorts, which had now been renewed. The sale at Grahamstown showed the satisfactory increase of 11·32 p.ct., which was equal to £655. The number of consumers there was also growing; and the consumption had increased by something like 1400 c.ft. per head. The leakage there, it was a happy thing to say, was very satisfactory. It worked out to only 2·6 p.ct. which was very low indeed. There were one or two things arising out of the report. One of the paragraphs had reference to the supply of electricity in Grahamstown. The Directors went into the matter very carefully as to the cost of putting up plant for the supply of electricity. The power to do this was in their concession. They might do it; but the Corporation were very anxious to do it themselves. The Directors came to the conclusion that it would not pay the Company to do it at all. Therefore at the present time the matter had dropped, though he supposed the Corporation were going to undertake it. Then, as the report showed, they were now having negotiations with the Corporation in regard to the supply of gas at the end of the concession. But these were not yet completed. In reference to the paragraph announcing the retirement of Mr. Andrew Don from the Board, those shareholders who had attended these meetings had known that he had been a regular attendant at them. Mr. Don had been a Director of the Association right from the beginning—32 years; and he was a very regular and faithful Director. Illness had obliged him to retire. The Board had considered how to fill up the vacancy, and they came to the conclusion there was no one more fitted to fill it, and who had greater knowledge of the working of the Association, than Mr. Cash, who had been their Secretary ever since 1891. He was therefore appointed to fill the vacancy. This, of course, left the Secretaryship vacant; and they very gladly appointed Mr. William Cash, jun., as their Secretary. Mr. Cash had had considerable experience; and he had proved himself during the time he had been Secretary to be a very able one, and a great help to the Board. They would see from the report that the Consulting Engineers were still named as "Corbet Woodall and Son." This firm was no longer in existence. There had been a change; and Mr. Henry Woodall who represented the firm here as Consulting Engineer had retired from it. He had in his office Mr. J. F. Scott, who was thoroughly familiar with all the working of the Association. In fact, all the calculations regarding the machinery and all the rest of it had been done by Mr. Scott, though under the name of Corbet Woodall and Son. The Board therefore thought they could not do better than appoint him to fill the vacancy as Consulting Engineer to the Association. He had been with them for some months; and his reports were exceedingly useful to them. He had a thorough grasp of the business, and he kept them *au fait* with everything that was going on. It was, he was sure, a most satisfactory appointment. In conclusion, he formally moved the resolution for the adoption of the report.

Mr. JAMES MACALISTER seconded the motion, which was carried unanimously.

The CHAIRMAN moved the declaration of a dividend of 8 p.ct. (subject to income-tax of 3s. 6d.) less the interim dividend of 4 p.ct. This, he remarked, was 1 p.ct. less than last year; but the loss of profit had obliged them to make the reduction. They would all agree that this was a wise thing to do. A good sum would still remain to be carried forward; but the Board must not deplete their resources for keeping the works and plant in good condition. The income-tax deduction of 3s. 6d. always sounded rather an odd figure, seeing that they had to pay here 6s., and not 3s. 6d. It was due to the fact that the income-tax they had to pay in South Africa was deducted from the income-tax levied here; and so at present it came to 3s. 6d.

Mr. HENRY WOODALL seconded the motion, which was at once agreed to.

The CHAIRMAN moved that Mr. Henry Woodall, who retired by rotation from the office of Director, be re-elected. He was an old Director; and his association with the Company dated from the beginning. Although he had a long journey to undertake to get to their meetings, he was invariably there; and his knowledge of the gas industry was such as to make him always an exceedingly useful colleague.

Mr. WILLIAM CASH said he seconded the motion with a great deal of pleasure. He had before him a file of the Company's accounts; and he saw that Mr. Woodall's name appeared as a Director in 1900. He (Mr. Cash) was sure that, on the Directors' side of the table, they would be very sorry indeed if Mr. Woodall's services did not continue available to them. He should like to take the opportunity of expressing his acknowledgments to the Chairman and the other members of the Board for the honour they did him in electing him a Director of the Company—a position he was very glad to fill. His own association with the Company went back to the start. This remark really applied to most of the gentlemen who were present, including their Auditor, who followed Mr. John G. Griffiths in that office.

The motion was heartily passed.

Mr. WOODALL thanked the shareholders very much for their continued confidence.

Mr. H. S. WHILE moved the re-appointment of the Auditor (Mr. Percival D. Griffiths, F.C.A.), at a fee of 40 guineas.

Mr. J. F. SCOTT seconded the motion, which was unanimously agreed to.

The CHAIRMAN said it was customary, and he believed it was a very proper thing for them to do, to recognize the services of their officers who worked so very far away from them. They were very faithful. Mr. Donaldson was their Engineer in South Africa. He was indefatigable, and most careful in his administration. He kept not only an eye on the Port Elizabeth station, but upon the Grahamstown one as well; and he wrote regular reports to their Consulting Engineer as to the work that was going on. Mr. Sterley, who was their local Secretary there, was an old servant of the Association, and was excellent in the way he presented the accounts and other statistics. There was Mr. Hart, the Superintendent at Grahamstown, who had also proved himself an excellent man. He (the Chairman) thought they ought to recognize the services of these gentlemen. It helped them in their work. It was therefore with much pleasure that he moved the resolution.

Mr. CASH said he should like to second the motion, because he was, and had been for a great many years, in possession of all the reports, documents, accounts, and correspondence which came from their

officers on the other side. He could thoroughly confirm what the Chairman had said. They had a zealous group of officers who performed their duties well. The shareholders were really very much indebted to them for their services.

The motion was unanimously carried; and this concluded the proceedings.

PLYMOUTH AND STONEHOUSE GAS COMPANY.

The Annual Meeting of the Company was held on Tuesday of last week—Mr. J. H. ELLIS in the chair.

The CHAIRMAN, in submitting the report and accounts, said numerous difficulties had been overcome, due to the unanimity of the Board of Directors and the ungrudging and able service of a loyal staff of workers. The accounts showed that the capital expenditure for the year amounted to £24,458, which, added to £12,000 paid for the redemption of debenture stock, converted a credit balance of £13,384 at the beginning of the year into a debit balance of £23,074 at its close. The total capital expenditure amounted to £447,091, or £328 per million cubic feet of gas—an exceptionally low and a most satisfactory figure. As to the revenue account, they had spent £173,189 for coal, an increase of £25,179 compared with last year, and for oil £45,676, an increase of £15,729. Last year they paid £40,908 for raw materials more than in the previous twelve months, and this was one of the difficulties they had had to face. This year their wages bill came to £92,704, or £15,169 more than last year, and no less than £66,563 more than in the year before the war; while on oil, coal, and wages they had had to pay £56,077 more than the previous year. Notwithstanding these heavy burdens, they had carried £22,667 to the credit of the profit and loss account—an increase of £16,648. After providing for dividend and debenture interest and bank charges, carrying £3500 to the renewal fund, and £820 to the redemption fund account, and debiting the account £337 less in realization of investments, there remained a credit balance of £24,196, compared with £22,506 last year. The outstanding items were £74,590 due to the bankers, and £11,601 expenditure on work and plant at present in course of completion. In 1914, their stocks of coal were of the value of £20,067; but last year they were valued at £62,412; while the amounts due to the Company in 1914 were £34,799, against £73,747 at the close of last year. From these figures it would be seen that upwards of £80,000 more working capital was necessary than in 1914. During the year they had sold for export, subject to license, a considerable quantity of coke; but they could have sold 3000 tons at least, which would have realized £22,500 at that time. However, the "dog in the manger" policy of the Government prevailed, and, consequently, they were deprived of that badly-needed working capital, and their consumers had to pay 3d. more per 1000 c.ft. for their gas—the shareholders, of course, also suffering. But the cause of all their troubles had been torn up by the roots—control had gone. They now had their freedom; and he was pleased to say that next half year the dividend would be practically the same as before the war. The benefit of being able to make gas of the material and quality they pleased was incalculable, which had been proved by the coal strike. When the strike began, they had no coal at all. What they had bought was seized by the Government; and for fully four weeks they did not carbonize an ounce of coal, but kept the town going by using coke and oil only. This would have been impossible, but for the skill of their Engineer (Mr. Percy S. Hoyte) and his staff, and the foresight in adding to their water-gas plant during the past few years. It was true that they supplied gas of low quality and they received many well-founded complaints; but the ingenuity of Mr. J. A. Richmond (the Distribution Superintendent), who invented a spiral spring,* stood them in good stead. Since that invention all complaints had ceased. They had tried more than 30,000 of these "rectifiers," and over 100,000 had been sent away. The activity of one of their engineering staff (Mr. Widlake) had also effected great economies. The reduction in the price of oil and other considerations enabled them to supply gas at a lower price per therm for the current year than most gas-works—4s. 1½d. per 1000 c.ft. It was only a reduction of ½d.: but next quarter it would be equivalent to 3s. 10¾d. per 1000 c.ft. They had agreed to buy the Plympton gas undertaking for £4500. They saw their way to reduce the price of gas from 8s. 9d. per 1000 c.ft., as at present, to an equivalent of 5s. The difficulties of small undertakings had so accumulated that they could not carry on except by supplying gas at a prohibitive figure. The output at Plympton was accordingly diminishing; and while the purchase relieved the existing proprietors from a dilemma, their own advantages would be manifest. He concluded by thanking the Secretary, Mr. Bolton, whose industry and ability were beyond praise.

The reports were adopted; and the Directors were authorized to borrow £69,835, the amount to be raised by the issue of new debenture stock, bearing interest at 7½ p.ct. per annum, to be redeemable at par on March 31, 1931.

* An account of this appeared in the "JOURNAL" last week (p. 689).

The long-anticipated outing of the Richmond (Surrey) Gas-Works Athletic Club took place last Saturday week, when a party numbering approximately eighty journeyed to Brighton for the day. Unfortunately, the President (Mr. E. George Hutchinson) was prevented from being in attendance; but his whole efforts had previously been extended in endeavouring to make the day a pleasant one, and the scenes both at the start and the termination of the journey fully proved that they were appreciated. All departments of the works were represented; and it was splendid testimony to the existence of a comradeship which in these days is a great asset for business success. Everyone spent a happy day, which gave the greatest satisfaction to the Hon. Secretary (Mr. T. G. Clark) and all those concerned in carrying out the arrangements.

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OLDHAM GAS ACCOUNTS.

Presenting to the Oldham Corporation Gas Committee the accounts for the year ended March 25 last, Mr. Ernest Parry (the Commercial Superintendent) says the gross revenue amounted to £419,478, and the gross expenditure to £394,133; the balance carried to profit and loss account being £25,345. Interest and sinking fund charges, &c., came to £32,166, making a net loss on the year's working of £6820. The debit balance brought from the previous year was £4538; and adding the sum of £7500 contributed to the borough fund, makes a debit balance to be carried forward of £18,858.

During the year under review, the average price per ton realized for coke was 40s. 1·58d., compared with 29s. 5·48d. per ton during the previous year; the total increase amounting to £16,098. The receipts for tar amounted to £36,436, representing an increase of £14,084. Tar fluctuated violently during the twelve months, the maximum prices realized being £9 1s. 7d. per ton for October, whereas for March the price only amounted to £3 per ton. The immediate prospect for tar values is very gloomy; and at the time of writing the report, prices were lower than for over two years. During the year the Committee had placed before them a co-operative tar scheme, which, after examination, was rejected, and a scheme prepared by himself put forward in lieu thereof.* At the moment, no definite arrangements had been completed for the sale of tar on this basis, though the Lancashire tar distillers accepted the scheme; and there is every likelihood that within the next few months definite arrangements will be made on those lines. Ammoniacal liquor values during the past year have been very good; and the receipts show an increase of £1477 when compared with the previous year. The immediate outlook is very black indeed; and the tar distillers have offered to place their plant at the disposal of gas undertakings up to the end of December next without profit. This conveys, in a very striking manner, what tar distillers think of the immediate future of ammoniacal liquor values.

The average cost of coal carbonized during the past year has been 38s. 0·89d. per ton, which represents an increase of 7s. 8·99d. per ton over the previous year. The total increase amounted to £42,487. Coal supplies during the winter were very difficult to obtain; but with the turn of the season, matters improved in this respect. When the miners' strike took place, the Committee were in as strong a position as for many years; while to-day, owing to the depletion of the accumulated stocks, their position is just the reverse, and next winter cannot fail to be very trying for all gas undertakings. It is now well-nigh impossible to put into stock sufficient tonnage to make them safe for next winter season. The coal supplied during last year did not improve in quality; and it is still far from being what they were accustomed to received in 1914.

The net price realized per 1000 c.ft. of gas sold during the past year was 4s. 1·66d., compared with 3s. 9d. the previous year. The quantity of gas manufactured last year was 1,643,356,000 c.ft., as against 1,607,238,000 c.ft. in the preceding year, being an increase of 36,118,000 c.ft. The average quantity of gas made per ton of coal carbonized (under the Engineer, Mr. Tim. Duxbury) was 14,612 c.ft., compared with 15,077 c.ft. in the previous year. The "Pleno" plant has been put to work during the year, and has given very satisfactory results.

* See "JOURNAL," *ante*, p. 202.

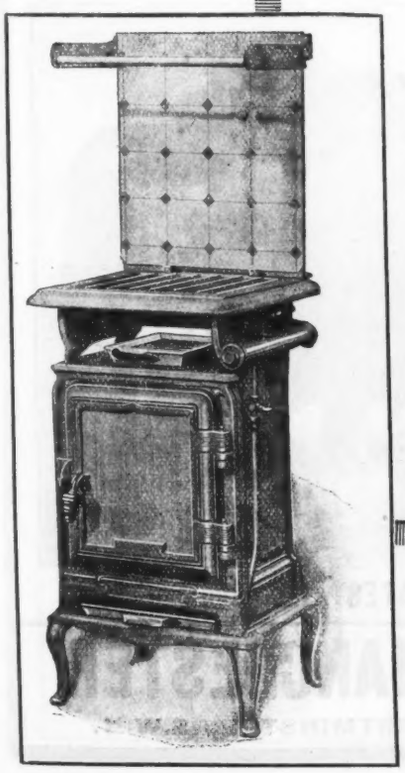
WORKINGTON GAS-WORKS RESULTS.

In moving the adoption of the report for the year ended March 31 of Mr. Hedley Hoy, the Engineer and Manager of the Workington Corporation Gas-Works, Alderman F. Hall (the Chairman of the Gas Committee) said the year under review constituted a record in every respect—as regarded results obtained, payments, and receipts. The Engineer was not responsible for profits only, as they were governed by actual working results. Gas made and sold, yield of gas per ton of coal carbonized, and residuals obtained were in advance of any previous year's working. Take the yield of 19,217 c.ft. per ton of coal carbonized, as compared with 18,031 c.ft. for the previous year. This was an increased yield of 1186 c.ft. per ton, which, put into concrete form, meant a saving of 560 tons of coal at 36s. 6d. per ton, or £1022. Wages, rates and taxes, material, and repairs to buildings were all greatly in excess of the previous year. There was an increase of £1044 in receipts for fittings, and £4040 for residuals. The final result was a gross profit of £5045—a record for the department.

To illustrate the effect of the price of coal upon costs, if they compared the 1915 coal price (15s. 3d. per ton) with 1921 (at 36s. 6d.), there was an advance of 21s. 3d. per ton. They used 8510 tons of coal, which made £9341 extra paid for coal. Had the price been as in 1915, they could have sold gas at 2s. per 1000 c.ft., instead of 4s. At present they were carbonizing anything black, and trying to extract gas from it. The works since the coal stoppage had been losing over £50 per week. As to the future, they were making provision, as far as possible, to avoid raising the price of gas, by adding, from the net disposable balance of £1357, £500 to the reserve for working capital, which would make this £4000. The balance of £857 would go to the reserve for renewals, &c., making this fund £1444.

A sum of £750 had been included in the estimates by Mr. Hoy for repairs to the vertical retorts, but had not been used, as they had held good. It spoke volumes for the good material and workmanship of the Woodall-Duckham Company, Ltd., and for the care and attention of their own staff and workmen, that the retorts had been run for six years continuously without its being necessary to renew a single one of them.

The total quantity of gas made was 163,544,000 c.ft., or an increase of 8·84 p.ct. on the make of the previous year.



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TRADE NOTES.

[For "Journal" Advertisers.]

Messrs. Sophus Berendsen (London), Ltd., who have moved their offices from Nos. 43 & 45, Great Tower Street, to No. 10, Philpot Lane, E.C. 3, have been appointed agents in this country for the Société Anonyme Compagnie Générale des Conduites d'Eau, of Liége, manufacturers of cast-iron pipes for gas and water mains.

CURRENT SALES OF GAS PRODUCTS.

The London Market for Tar, Tar Products, and Sulphate.

London, *June* 27.

The market for tar products continues inactive; prices, if anything, showing a slightly harder tendency in most products, owing to the shortage of production due to the coal strike. There is a fair amount of interest in pitch for next season, and buyers are coming up slowly in their ideas of value; but makers are not in a hurry to sell. The large demand for road tar on top of the shortage of output should have a strengthening effect on the position. Creosote is steady at about 9d. to 9¼d. per gallon. Solvent naphtha is scarce at from 2s. 9d. to 3s. per gallon. Pure benzole and pure toluol about 3s. to 3s. 3d. per gallon.

Sulphate of ammonia for prompt delivery for the home trade remains unaltered at £18 10s. per ton, basis 24¾ p.ct., with a discount of 3 p.ct. to dealers.

Tar Products in the Provinces.

June 27.

The average values for gas-works products during the week were: Gas-works coal tar, 57s. 6d. to 61s. 6d. Pitch, East Coast, 70s. to 75s.; West Coast—Manchester, 70s. to 72s. 6d.; Liverpool, 70s. to 72s. 6d.; Clyde, 70s. to 72s.6d. Benzole 90 p.ct. North, 2s. 4d. to 2s. 6d.; crude 65 p.ct. at 120° C., 1s. 11d. to 2s., naked at makers' works; 50-90 p.ct., naked, North, 2s. 3d. to 2s. 4d. Toluol, naked, North, 3s. to 3s. 1½d. nominal. Coal tar crude naphtha in bulk, North, 11d. to 11¼d. Solvent naphtha, naked, North, 2s. 3d. to 2s. 4d. Heavy naphtha, North, 2s. 7d. to 2s. 9d. Creosote, in bulk, North, liquid, 9d. to 9¼d.; salty, 8¼d. to 8¾d. Heavy oils, in bulk, North, 10½d. to 11½d. Carbolic acid, 60 p.ct., 1s. 6d. Naphthalene, £20 to £30; salts, £7 to £9, bags included. Anthracene, "A" quality, 8d. to 10d. per minimum 40 p.ct.; "B" quality, nominal.

In our issue for June 15 the price of pitch, East Coast, was omitted through a printer's error. The figure should have been 70s. to 72s. 6d.

FROM A MARKET CORRESPONDENT.

Tar Products.

June 28.

The position has not changed for the better. Although the miners are gradually drifting back to work, the majority are still out, and very little improvement in coal supplies can be anticipated for some time. The effect of this on the bye-products trade has been to cause considerable further depression. There are supplies available, and consequently a very small demand is sufficient to harden prices in most instances. Pitch remains from 65s. to 75s. per ton. Benzole still makes 2s. 10d. per gallon for 90 p.ct., and 3s. to 3s. 2d. for pure. Creosote oil is scarce for immediate delivery, and is quoted at 9d. per gallon in the North and 10d. in the London district. There is no change in carbolic or cresylic acids; and solvent naphtha is rather dearer at 2s. 8d. Naphthalenes remain the same. Intermediate products have fallen back on the postponement of the re-opening of most of the works. There are still considerable inquiries for aniline oil and salt at 1s. 8d. and 1s. 10d. respectively. Salicylic acid maintains its upward movement; being quoted at 1s. 4d. per lb.

Sulphate of Ammonia.

This material remains in the neighbourhood of £18 per ton for home delivery, and just under £16 per ton for export. There is nothing to report about the trade except that farmers do not appear altogether satisfied with the change of quotations, and are not yet placing orders for next season's deliveries.

Malta and Mediterranean Gas Company, Ltd.—At the meeting on Tuesday of next week [July 5], the Directors will report that the accounts for the year ended March 31 show a balance of £8631. After providing for interest, income-tax, &c., and the loss resulting from writing-down the assets at Sicily to the rate of exchange ruling on March 31, there remains a sum of £3217 standing to the credit of the profit and loss account. The Directors propose to pay a dividend of 7 p.ct. (less tax) on the first preference shares, and of 5 p.ct. (less tax) on the second preference shares for the year, leaving a balance of £214 to be carried forward, subject to payment of Corporation Profits Tax for the current year. No money has yet been received from the Italian Government on account of the claim made against them for the losses sustained in carrying on the works at Trapani and Marsala during the war. The Directors regret the retirement from the Board of Colonel Stephenson R. Clarke, C.B., after being a Director of the Company for 29 years. Mr. Arthur F. Phillips, M.Inst.C.E., has been appointed to the chair; and the vacancy on the Board has been filled by the election of Mr. Frank H. Jones, M.Inst.C.E., as a Director of the Company.

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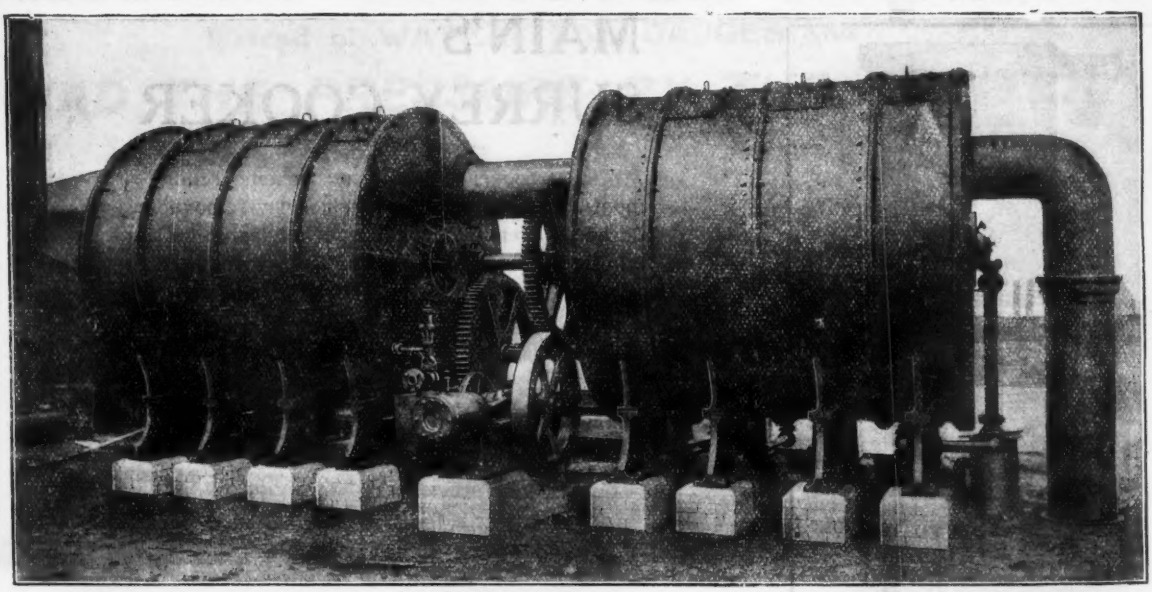

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Bournemouth Gas Supply and the Strike.

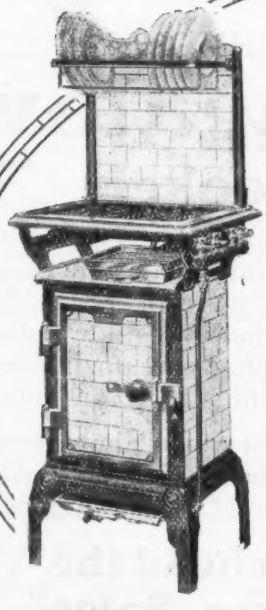
Writing in the latest issue of the Bournemouth Gas and Water Company's magazine, the "Co-Partner," Mr. Philip G. G. Moon, the Engineer, says that, in spite of the long coal strike, the 130,000 people who live in the Company's area of supply have felt ,at any rate so far as their domestic arrangements are concerned, very little inconvenience. It is estimated that there are approximately 30,000 houses in the Company's gas area; and of these all, except about 200, have gas installed in some form or another. In these houses there are 27,000 gas-cookers, 34,000 gas-fires, and thousands of water-heaters, in addition to numberless gas-rings, grillers, and special apparatus. Gaseous fuel, distributed through some 300 miles of mains, has quietly, but effectively, carried the means of cooking and heating into nearly every home in the twenty miles of country that lies between Hamworthy and Milford-on-Sea. The Company, under normal conditions, use 80,000 tons of coal per annum; and, if no precaution had been taken, they would by now have been in a very precarious position. Fortunately, it was realized very early in the year that there was likely to be trouble in the coalfields; and steps were taken to accumulate as large a stock of coal as possible. As a result, when the strike started, the Company had in hand 14,000 tons of coal, which had cost between £30,000 and £40,000. This, under normal conditions, represented from seven to eight weeks' supply; but by increasing the percentage of water gas in the mixture distributed, a saving was effected in the coal used, which materially extended this period. In addition to this, the Company have been able to secure about 2000 tons of French coal from the Pas de Calais, which, though expensive and of inferior quality, has increased the stock of coal sufficiently to last for well over another month. In spite of the reduction in public lighting, the easing of the district pressures, and the appeals for economy, the amount of gas used has largely exceeded that of the corresponding period of any previous year.

Position of the Gas Supply at Whitchurch.—In the course of a statement made at the last weekly meeting of the Fuel Committee of the Whitchurch Urban District Council, Mr. J. F. Tyndall, the Manager of the Whitchurch Gas Company, Ltd., said he regretted there was no improvement to report regarding his efforts to secure coal supplies. The Company had bought heavily of all the available outcrop and pit-bank pickings—in fact, there was no difficulty in obtaining ample coal supplies of a sort—*i.e.*, they all gave some gas; but every sample lacked coking qualities. Not more than 20 p.ct. of the usual quantity of coke was available. In such circumstances, it was not possible to obtain sufficient coke to maintain heats; and, so far as he could estimate, the entire gas supply to the town would cease on Sunday evening, July 3, unless something turned up meantime. The special cooking pressures given for breakfast, dinner, and tea, would at once be discontinued, and the pressure would be constant throughout the day until the closing-down.

United States Safety Council.

Mr. C. W. Price, the General Manager of the National Safety Council, writing in the "American Gas Journal," says that attention to safety must begin at the top. The manager and the superintendent must believe in it as a business proposition, just as they believe in fire prevention or anything else that prevents waste or increases efficiency. They must give safety a dignified position in the organization, so that every foreman and workman may know what the officers propose to do to make the plant safe, and what they expect the foremen and workmen to do. Without this backing from the manager and the superintendent, little can be done in the way of reaching the workmen and awakening the real safety spirit. Evidence of many large undertakings affords conclusive proof that safety work pays good dividends on the investment. Take, for instance, the experience of six members of the National Safety Council. The Commonwealth Steel Company reduced the cost of accidents during the five years to December, 1918, from $40,000 to about $4500 per annum. During three months in 1918, with 2500 men, they had no compensation case. The Eastman Kodak Company, in the first five years of safety work, reduced lost time through accidents by 80 p.ct., and the annual cost of accidents from $35,000 to $3500. The Omaha plant of the American Smelting and Refining Company, comparing 1916 with 1915, reduced lost-time accidents by 90 p.ct., and eliminated deaths. Another big structural steel company, with a force of 1050 men, reduced the cost of compensation during 1917 to 12½c. per $100 pay roll. The United States Steel Corporation in the first eleven years of safety work (in comparison with the record of 1906), saved 19,815 men from being killed, permanently crippled, or so seriously injured as to lose over 35 days' time. The International Harvester Company, with twenty-three plants, including coal mines and a steel works, as well as foundries, machine shops, and wood-working shops, during the first five years of safety work, reduced compensation to 25c. per $100 pay-roll. In the steel plant, serious accidents were reduced more than 75 p.ct.

Further Purifying Plant for Birkenhead.—An inquiry on behalf of the Ministry of Health was last week held at Birkenhead, with regard to an application by the Corporation for authority to borrow £20,400 for the erection of purifying plant in connection with the gas-works. The Gas Engineer (Mr. R. H. Brown) stated that during the present crisis 80 p.ct. of the gas produced at the works was water gas. It was cheaper to make coal gas, because of the residuals; and immediately the miners' dispute was settled, a greater percentage of coal gas would be produced. It was proposed to begin the erection of the two new purifiers as soon as the Ministry sanctioned the loan. When the estimate was prepared, the amount applied for was considered sufficient; but since then pig iron had increased in price, and it was possible that the original estimate might be exceeded. The Inspector (Mr. M. K. North) was informed that a profit of £5000 was made by the gas-works last year.



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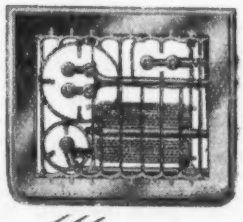

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Walsall Gas Restriction.—A new regulation at Walsall prohibits the use of gas after 6 p.m. each day. It is intended also in Walsall and the surrounding districts of Pelsall, Aldridge, Sheffield, and Great Barr to put the price of gas up 6d. per 1000 c.ft., commencing in July.

Chirk Gas Company, Ltd.—At the Wrexham County Court last week, his Honour Judge Bryn Roberts granted an application to reduce the capital of the Chirk Gas Company, Ltd., from £4360 to £2180; the shares to be £5, instead of £10. His Honour said he was satisfied that the interests of the creditors were unaffected.

Discontinuance of Supply Notified at Shotley Bridge.—Notice was given by the Shotley Bridge and Consett District Gas Company that, in consequence of the exhaustion of their coal stock and the stoppage of further supplies, they would be compelled to discontinue the supply of gas to all consumers after last Sunday, the 26th inst., until further notice.

Increase in Price at Blackpool.—The Blackpool Gas Committee have decided to revise the price of gas from the end of this month. Since April 1, fuel costs, &c., have been £21,424 more than normal. For ordinary consumers, the price of gas is increased from 3s. 9d. to 4s. 6d. per 1000 c.ft.; and for power, from 3s. 4d. to 4s. 2d. These increases are expected to add £21,115 to the revenue by the end of the financial year. Since April 1 the consumption of gas has decreased by 6½ p.ct.

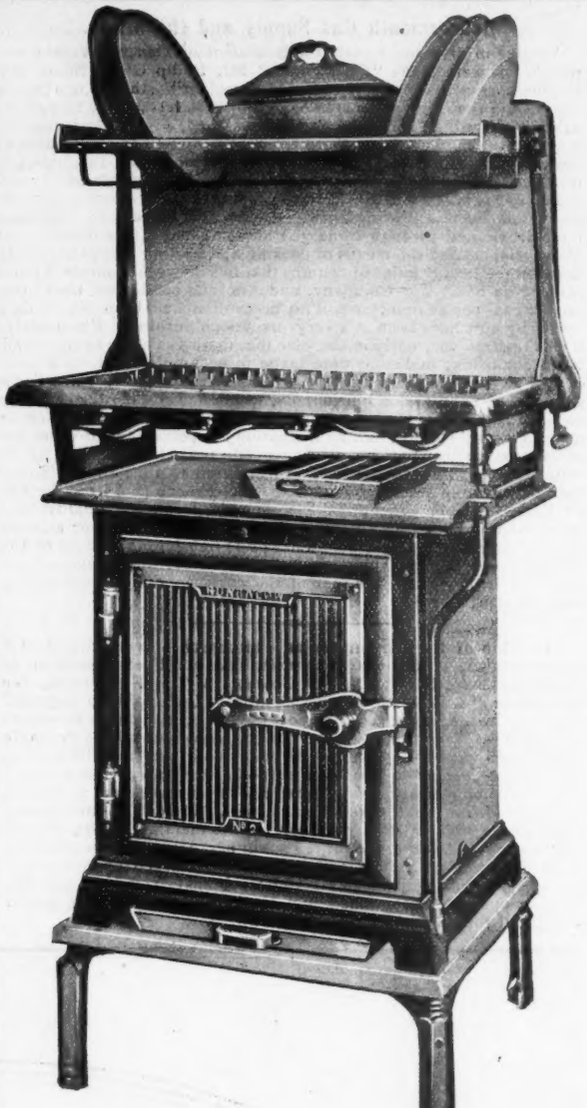
Financial Statement at Bingley.—The annual financial statement of the Bingley Gas Department, presented at a meeting of the District Council last week, showed for the year ended March 31 a gross profit of £3343, leaving a net profit of £2245 after deductions for interest and sinking fund. This profit enabled the balance owing to the reserve to be reduced from £4340 to £2094. The Council approved an increase in the price of gas by 6d. per 1000 c.ft. from July 1, making the charge 4s. 6d.

Grantham Gas-Fitters' Dispute.—Effective means were adopted last week by the Grantham Master Builders' Association to put a stop to a labour dispute in which plumbers and gas-fitters employed by the local Gas Company threatened to interfere with the progress of the municipal housing scheme. The Builders' Association called upon the plumbers last Wednesday to resume work immediately, failing which it was threatened there would be a lock-out of the whole of the members of the Building Trades Operatives' Federation in Grantham. The result was that the plumbers returned to work pending further negotiations,

Prices of "N.B.C." Benzole Lubricants Reduced.—Intimation has been received from the National Benzole Company, Ltd., of a recent reduction in the prices of "N.B.C." lubricating oils. The prices now are as follows, for medium and heavy, in bulk, per gallon, including cost of package, and delivered free to any address within the railway companies' delivery radius. In barrels of 40 gallons: Retail, 6s. 9d.; commercial users, 6s.; trade, 5s. 9d. In drums of 10 gallons, 7s. 6d., 6s. 9d., and 6s. 6d.; and in drums of 5 gallons, 7s. 9d., 7s., and 6s. 9d. Supplied by approved garages from bulk in own packages, retail, 7s. 3d., and commercial users 6s. 6d. The allowance for empty barrels is equal to 2¼d. per gallon reduction on the price. The following special rebates are made on trade contracts for supplies in barrels (delivered within twelve calendar months): Quantities exceeding 500 gallons, 1d. per gallon; 1000, 2d.; 1500, 3d.; 2000, 4d.; 2500, 5d.; 3000, 6d.

Birmingham's Restricted Gas Consumption.—The Birmingham Gas Committee state that the weekly gas consumption is 150 million cubic feet with the restrictions. During the corresponding period of last year, the output was 210 millions. The week before the coal stoppage, the weekly consumption was 240 millions. Most of the coal now used is American, which has been bought at a high price. The Gas Committee point out that it is impossible, for safety reasons, entirely to cut-off the supply. When the pressure is reduced to the minimum, what gas there is in the pipes rises to the higher parts of the city, where, if people choose to be disloyal, supplies can be obtained at reduced pressure for a considerable time after the hours at which it is sought to cut-off the gas. The department state that it is quite evident from the results that the necessary steps must be taken to teach the public that they must not defy the regulations when placed in a position to do so. Experiments are being made with a view to the production of gas from air-dried wood which was obtained by the Government during the war for the manufacture of charcoal. It consists chiefly of specially selected oak and beech, and is placed in horizontal retorts, where it is converted into gas of inferior quality. This is being mixed with the other gas in small proportions. Experiments are also being made in the direction of gas production from disused wood pavement blocks.

Fatality at Swan Village (Birmingham) Gas-Works.—An inquest was held last Saturday on the body of Frederick Downes (27), an erector, who lost his life at the Birmingham Corporation gas-works at Swan Village on Thursday. Downes was in the employ of Messrs. Whittaker Ellis, Ltd., contractors, and was engaged with two other men in clearing an old disused pit shaft. The men had been down on the two previous days, and on Thursday Downes was lowered to a depth of about 23 ft. He shouted "All right" on reaching the bottom; and his companions, on hearing no other sounds, called out to him. As they got no reply, they raised an alarm. Two other men tried without success to get down to him; and the rescue party from the gas-works was sent for. A man, wearing a gas helmet, reached Downes, who was raised to the surface apparently dead. There was no evidence of gas in the shaft. Mr. Browning, the Engineer at the works, stated that the object was to find the water level in the shaft; and the contractors took all responsibility. He expressed the opinion, in reply to the Factory Inspector, that at the bottom of the pit there was a certain material which, when exposed to the damp atmosphere, absorbed oxygen and released a poisonous gas. He thought this must have been "tapped" on the evening before the accident, with the result that it had accumulated at a low level, and when Downes stooped to pick up his shovel he got into the gas, and it would prove fatal. A verdict of "Death from misadventure" was returned; the Jury expressing the opinion that adequate precautions were taken.



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THE RICHMOND

GAS STOVE AND METER CO., Ltd.

WARRINGTON AND LONDON.

At last week's meeting of the London County Council, an estimate of £60,400 was approved in respect of the supply of gas and electricity in connection with the education service for the financial year 1921-22.

At the annual meeting of the Comrie (N.B.) Gas Light Company it was intimated that the rate for gas would be increased by 10d. per 1000 c.ft. No dividend is declared, and none has been paid for three years. It was reported to the proprietors that the works were in a satisfactory condition.

Among a large number of oil-fuel burning appliances recently installed, Messrs. Meldrums, Ltd,, of Timperley, near Manchester, mention the fitment of oil-burners to a water-tube boiler for the Colwyn Bay Urban District Council. Also "Meldrum" forced-draught furnaces to a Babcock and Wilcox boiler for the Ealing Borough Council, and a tar-still for the Newcastle-upon-Tyne and Gateshead Gas Company.

Messrs. Falk, Stadelmann, and Co., Ltd., of Farringdon Road, E.C., are issuing a list (No. 690) showing the reduced prices that are being quoted by them (with the object of reducing stocks) for plain and fancy glassware for upright and inverted burners.

By an accident stated to have been caused by back-firing due to the nature of the coal now being used, Joseph Shanley, a stoker at the Brierfield Gas-Works of the Nelson Corporation, was so seriously burned all over the body as to necessitate his removal to hospital.

By order of the Directors of the Plymouth and Stonehouse Gas Light and Coke Company, Messrs. A. & W. Richards are issuing £69,835 of 7½ p.ct. redeemable debenture stock. The issue price is par, and the stock is to be redeemed at par on March 31, 1931. The capital is required to repay money already borrowed from the Company's bankers to meet the cost of extension of works and plant rendered necessary by the growing demand for gas. The latest time for applications is 11 o'clock on Thursday, June 30.

STOCK MARKET REPORT.

THE state of things on the Stock Exchange last week presented hardly any feature of novelty; but the general feeling in regard to prospective developments in labour questions was perhaps a little less despondent after the first two or three days, which had ruled decidedly dull. Thus aided, and cheered by the lowering of the Bank rate on Thursday last, the general tone improved.

The gilt-edged market made some advances. Home Government securities were somewhat chequered; only two of the big four showing a rise. Friday's figures were: Consols 45⅝-46¼, War Loan 87⅞ 88⅛, Funding 71⅜-71⅝, Victory 77-77½. Bonds moved uncertainly; but Corporation issues did well, and Indians closed firm. Home Rails were easier for the most part, and Canadians and Argentines were dull also.

The Foreign Market had a few good points. French, Chinese and Japanese stocks closed well; but German, Mexican, and Peruvian receded.

In the Miscellaneous Market, Rubber was weak, though the final prices were not the worst of the week. Oils were irregular. A little improvement was perceptible in Iron and Steel and Shipping.

Business in the Gas Market showed a great falling-off in point of volume, cumulative upon the marked reduction of last week, the reason for which is not apparent unless it be the superior claims of sport over business. There was hardly any movement in prices; but that little was downward. In the London Companies, Gas Light ordinary and South Metropolitan were a point lower; but there were no dealings in Commercial. There were a few transactions in Suburban and Provincial at the old figures without any change. In Continentals, Europeans looked like rising; but Imperial's quotation was lowered 2.

Bargains done for cash during the week were as follows: On Monday, European 7¼, Gas Light ordinary 54⅛. 54½, 54⅝. 55½, ditto maximum 42, ditto debenture 49, Imperial Continental 133, 134, South Metropolitan 67½, ditto debenture 48, Tottenham "A" 59⅜, 60, Cardiff 7 p.ct. debenture, £50 paid, 49½. 50½, Liverpool 5 p.ct. ordinary 53¾. On Tuesday, Brentford "B" 61½, 62, Continental Union 17, ditto preference 27, 30, European 7⅛, Gas Light ordinary 54⅛. 54⅝, Hornsey 77½, 78, Imperial Continental 133, Primitiva 9s., preference 26s. 9d., South Metropolitan 67, ditto debenture 47⅞, Tottenham "B" 54½. 54¾, Cardiff 7 p.ct. debenture, £50 paid, 50, Hornsey 5 p.ct. preference 65½, Malta and Mediterranean 7½ p.ct. preference 37s. 6d., 38s. 3d. On Wednesday, British 22½, Continental Union 19⅞, Gas Light ordinary 53½. 54. 54⅛. ditto maximum 43, Imperial Continental 132 (and exceptional 100), South Metropolitan 67, 67¼, Barnet District "D" 68, 68½. On Thursday, Brighton and Hove original 98½, British 22, European 7⅛, Gas Light ordinary 53½. 54. 54½, ditto maximum 42⅞. 43, ditto debenture 49¾, 50, Imperial Continental 130½, 131, 132 (and exceptional 100), Primitiva preference 26s., ditto debenture 66. 66½, South Metropolitan 67½, Brighton and Hove 6 p.ct. preference "B" 75, 75⅛, Cardiff 7 p.ct. debenture, £50 paid, 50. On Friday, Bournemouth 5 p.ct. £7 7s., Gas Light ordinary 53½, 54⅛, Imperial Continental 132, Primitiva preference 26s., South Metropolitan 67, Ipswich 7½ p.ct. "B" 103.

In the Money Market, the event of the week was the long-looked-for lowering of the Bank rate on Thursday to 6 p.ct. from the 6½ p.ct. fixed on April 28. For some days supplies were abundant, and the position was quite easy; but towards the close a considerable demand sprang up. Silver became easier.

ANTE-WAR PRICES AND DIVIDENDS, LATEST DIVIDENDS, AND LAST WEEK'S BARGAINS.

Issue.	Share.	When ex-Dividend.	Ante-War Dividend & Bonus.	Last Dividend.	NAME.	Closing Prices, July 30, 1914.	Present Prices.	Lowest and Highest Prices of Bargains.
£			p.c.					
182,049	Stk.	Mar. 11	4	4%	Aldershot 4 p.c. Pref.	...	33—38	...
1,551,868	,,	Apl. 14	9½	3½%	Alliance & Dublin Ord.	59—64	39—44	...
374,000	,,	Jan. 13	4	4%	Do. 4 p.c. Deb.	76—79	47—52	...
280,000	5	Oct. 28	7½	5%	Bombay, Ltd.	5½—6½	3½—4½	...
100,000	5	Feb. 25	16	5%	Bournemouth Gas and Water: 5 p.c.	...	7½—8½	£7 7/-
383,110	10	,,	7	7%	Bournemouth Gas and Water: B 7 p.c.	15—15½	8½—9½	...
115,000	10	,,	6	6/-	Bournemouth Gas and Water: Pref. 6 p.c.	13½—14	7½—8½	...
162,065	—	Dec. 30	—	4%	Bournemouth Gas and Water: 4 p.c. Deb.	...	55—60	...
992,045	Stk.	Feb. 25	14	30/-	Brentford A Consolid.	261—266	66—71	...
734,980	,,	,,	11	26/3	Do. B New	204—209	60—65	61½—62
55,000	,,	,,	5	5%	Do. 5 p.c. Pref.	109—111	68—73	...
221,400	,,	June 13	4	4%	Do. 4 p.c. Deb.	91—93	56—58*	...
214,775	,,	Mar. 11	11	7½%	Brighton & Hove Orig.	208—213	95—105	98½
244,200	,,	,,	8	5½%	Do. A Ord. Stk.	154—159	65—75	...
1,287,500	Stk.	July 29	5	5%	Bristol 5 p.c. max.	...	...	...
530,000	20	Mar. 30	12½	10%	British	44—45	28—34	22—22½
120,000	Stk.	Dec. 30	4	4%	Do. 4 p.c. Deb. Stk.	88—90	50—55	...
245,771	,,	,,	4	4%	Buenos Aires 4 p.c. Deb.	85—87	37—40	...
100,000	10	May 27	—	6%	Cape Town & Dis., Ltd.	1½—2½	6½—7½	...
100,000	10	Apl. 28	—	4½%	Do. 4½ p.c. Pref.	4—6	4½—5½	...
100,000	Stk.	Dec. 30	4½	4½%	Do. 4½ p.c. Deb. Stk.	70—75	55—60	...
137,150	,,	Feb. 26	5	5%	Chester 5 p.c. Ord.	108—110	...	...
1,513,380	,,	Feb. 25	5/9/4	30/-	Commercial 4 p.c. Stk.	106—108	55—60	...
560,000	,,	,,	5½	26/3	Do. 3½ p.c. do.	103—105	52—57	...
475,000	,,	June 13	5	5%	Do. 3 p.c. Deb. Stk.	69½—71½	42—45*	...
800,000	,,	Dec. 11	4	—	Continental Union Ltd.	76—79	17—22	17—19½
200,000	,,	,,	7	—	Do. 7 p.c. Pref.	115—118	30—40	27—30
51,600	,,	Feb. 5	15	10%	Croydon A 10 p.c.	...	125—135	...
278,400	—	,,	12	7%	Croydon B and C 7 p.c.	...	95—105	...
492,270	Stk.	—	6	4½%	Derby Con. Stk.	123—125	...	...
55,000	,,	—	4	4%	Do. Deb. Stk.	102—104	...	...
1,002,180	10	Jan. 29	10	5/0	European, Ltd.	17½—18	6½—7½	7½—7⅝
16,298,975	Stk.	Feb. 10	4/17/4	30/-	Gas Light and Coke: 4 p.c. Ord.	98—102	53—56	53½—55½
2,600,000	,,	,,	5½	26/3	Gas Light and Coke: 5½ p.c. max.	76—79	42—45	42—43
4,062,233	,,	,,	4	4%	Gas Light and Coke: 4 p.c. Con. Pref.	96—99	56—59	...
4,674,850	,,	June 15	5	5%	Gas Light and Coke: 5 p.c. Con. Deb.	72½—74½	48—51*	49—50
130,000	,,	Dec. 11	10	10%	Gas Light and Coke: 10 p.c. Bonds.	...	...	...
82,500	,,	Mar. 11	5	3½%	Hastings & St. L. 5 p.c.	...	48—53	...
258,740	,,	,,	3½	2½%	Do. 3½ p.c.	87—89	34—39	...
70,000	10	May 12	11	5%†	Hongkong & China, Ltd.	16½—16¾	5—6	...
86,600	Stk.	Mar. 11	9	5½%	Hornsey 7 p.c.	...	75—85	77½—78
131,000	,,	Mar. 30	7½	3½%	Ilford A and C	151—154	76—81	...
65,780	,,	,,	6½	2½%	Do. B	115—118	55—60	...
63,500	,,	Dec. 30	4	4%	Do. 4 p.c. Deb.	92—94	54—56	...
1,976,000	,,	May 27	9	5%†	Imperial Continental	150—160	130—135	130½—134
1,235,000	,,	Feb. 10	3½	3½%	Do. 3½ p.c. Deb. Red.	84—86	76—81	...
233,242	,,	Mar 30	6½	3½%	Lea Bridge Ord. 5 p.c.	119—121	65—70	...
1,498,903	,,	Feb. 26	10	57/6	Liverpool 5 p.c. Ord.: A.	211—213	...	53½
					Liverpool 5 p.c. Ord.: B.	146—148	...	...
306,083	,,	June 26	4	4%	Do. 4 p.c. Pr. Deb. Stk.	...	...	...
165,736	,,	Feb. 25	7/5/6	3½%	Maidstone 5 p.c.	...	52—57	...
75,000	5	June 11	6	5%	Malta & Mediterranean	4½—4¾	1½—2½	...
250,000	100	Apl. 1	4½	4½%	Met. of Melbourne 4½ p.c. Deb.	99—101	88—93	...
541,920	Stk.	May 27	4	6%	Monte Video, Ltd.	11½—12	60—70	...
1,875,892	,,	Feb. 25	4½	3½%	Newcastle & Gatsh'd Con.	98½—99½	50½—60½	...
529,705	,,	Dec. 30	3½	3½%	Do. 3½ p.c. Deb.	82—85	50—52	...
15,000	10	Mar. 11	—	8%	North Middlesex 10 p.c.	...	12½—13½	...
55,940	10	,,	7/14/0	5½%	,, ,, 7 p.c.	14—15	7½—8½	...
300,000	Stk.	May 12	8	8%	Oriental, Ltd.	117—122	87—92	...
60,000	5	Mar. 26	10	1/-	Ottoman, Ltd.	7½—7¾	2—3	...
188,120	Stk.	Jan. 13.	—	3½%	Plym'th & Stoneh'se 5 p.c.‡	...	55—60	...
60,000	50	Feb. 25	13	7½%	Portsea Island, B	128—131	65—70	...
100,000	50	,,	12	6½%	Do. C	118—121	50—55	...
249,980	5	April 29	8	—	Primitiva Ord.	5½—6	½—¾	9/-
499,960	5	June 26	5	—	Do. 5 p.c. Pref.	4½—5	1½—1¾	26/—26/9
521,600	100	June 1	4	4%	Do. 4 p.c. Deb.	91—93	65—67	66—66½
600,000	Stk.	Jan. 27	4	4%	Do. ,, ,, 1911	...	37—40	...
346,198	,,	Dec. 30	4	4%	River Plate 4 p.c. Deb.	85—87	37—40	...
150,000	10	Mar. 30	6	6/-	San Paulo 6 p.c. Pref.	10½—11	5½—6½	...
125,000	50	Jan. 3	5	5%	San Paulo 5 p.c. Deb.	47—49	35—40	...
135,000	Stk.	Mar. 30	10	5%	Sheffield A	223—224	62—64	...
209,984	,,	,,	10	4½%	Do. B	222—224	62—64	...
523,500	,,	,,	10	3½%	Do. C	220—222	59—61	...
133,201	Stk.	Sept. 15	4	4%	Shrewsbury 5 p.c.	...	...	...
90,000	10	Sept. 30	9	9%	South African	10½—11½	9—11	...
6,609,895	Stk.	Feb. 10	5/4/0	5%	South Met. Ord.	111—113	66—68	67—67½
250,000	,,	Jan. 13	—	5%	Do. Red. Pref.	...	90—92	...
1,895,445	,,	,,	5	5%	Do. 3 p.c. Deb.	72½—74½	46—49	47½—48
224,820	,,	Feb. 25	8½	7½%	South Shields Con. Stk.	157—159	85—87	...
1,087,795	,,	,,	6	3½%	S'th Suburb'n Ord. 5 p.c.	114—116	58—63	...
368,837	,,	Dec. 30	5	5%	Do. 5 p.c. Deb. Stk.	116—118	72—77	...
647,740	,,	May 12	7½	3½%	Southampton Ord.	99—102	55—58	...
121,275	,,	Dec. 30	4	4%	Do. 4 p.c. Deb. Stk.	...	57—59	...
120,000	,,	Feb. 25	—	3½%	Tottenham A 5 p.c.	135—138	57—62	59½—60
782,275	,,	,,	6	2½%	Tottenham District B 3½ p.c.	115—117	50—55	54½—54½
181,255	,,	June 13	4	4%	Tottenham District 4 p.c. Deb.	87—89	52—55*	...
182,380	10	Dec. 30	5	—	Tuscan, Ltd.	5—6	1—2	...
149,900	10	July 1	5	5%	Do. 5 p.c. Deb. Red.	93—95	45—50	...
236,476	Stk.	Feb. 25	5	3½%	Tynemouth 5 p.c. max.	108½—109	68—70	...
					Wandsworth, Wimbledon, and Epsom—			
30,000	,,	Feb. 25	8½	47/6	Wandsworth A 5 p.c.	151—156	78—83	...
235,636	,,	,,	6½	32/6	Do. B 3½ p.c.	129—134	55—60	...
108,073	,,	,,	—	33/3	Do. C	...	55—60	...
140,863	,,	,,	—	33/3	New Ordinary	...	55—60	...
352,000	,,	,,	6½	26/3	Wimbledon 5 p.c.	117—122	57—62	...
98,000	,,	,,	6½	32/6	Epsom 5 p.c.	121—126	55—60	...
88,416		Dec. 30	¼	¼%	¼ p.c. Deb. Stk.	66—69	40—45	...

* Ex Div. † Next dividend will be at this rate. ‡ Plymouth & Stonehouse is now quoted officially in London.

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GODFREY W. KAYE,
Secretary.

Gas Department,
Town Hall, Manchester,
June 23, 1921.

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Canvassing, Directly or Indirectly, will be held to be a Disqualification.

A. GRIERSON, S.S.C.,
Town Clerk.

City Chambers, Edinburgh,
June 20, 1921.

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Apply, by letter, giving Experience and full Particulars, to No. 7049, care of MR. KING, 11, Bolt Court, FLEET STREET, E.C. 4.

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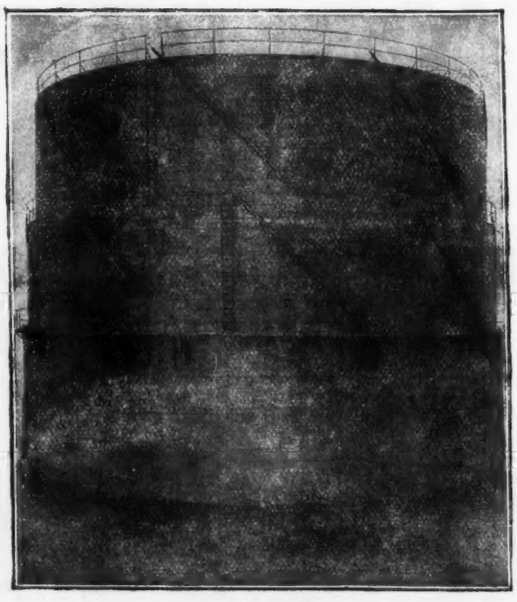

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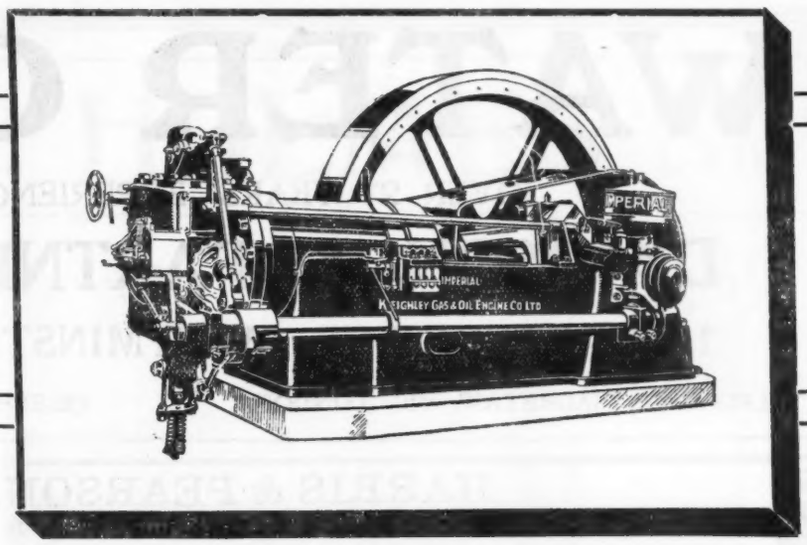

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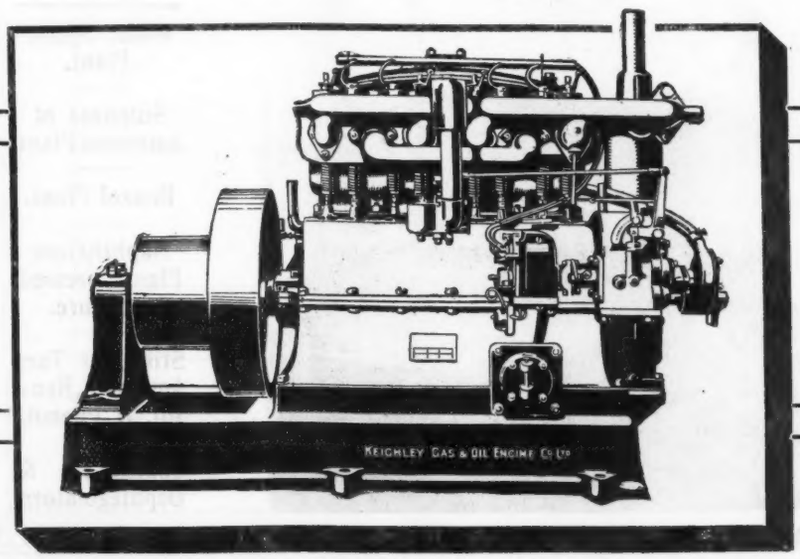

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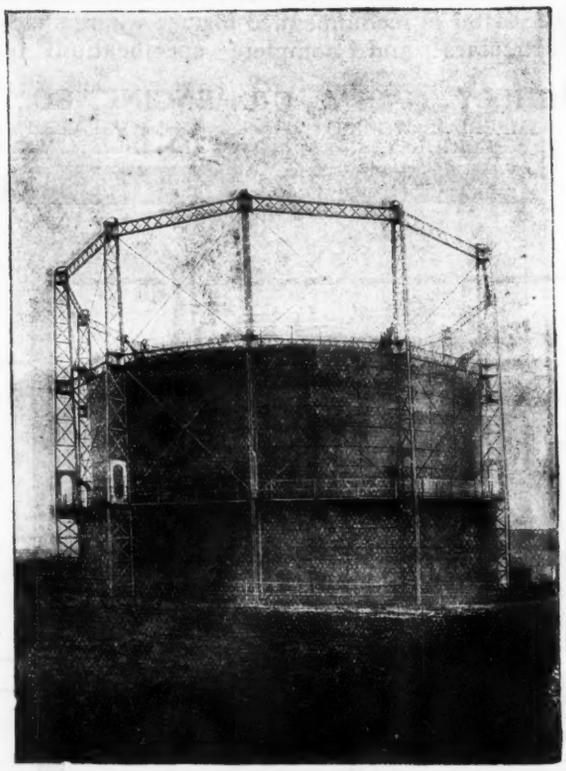

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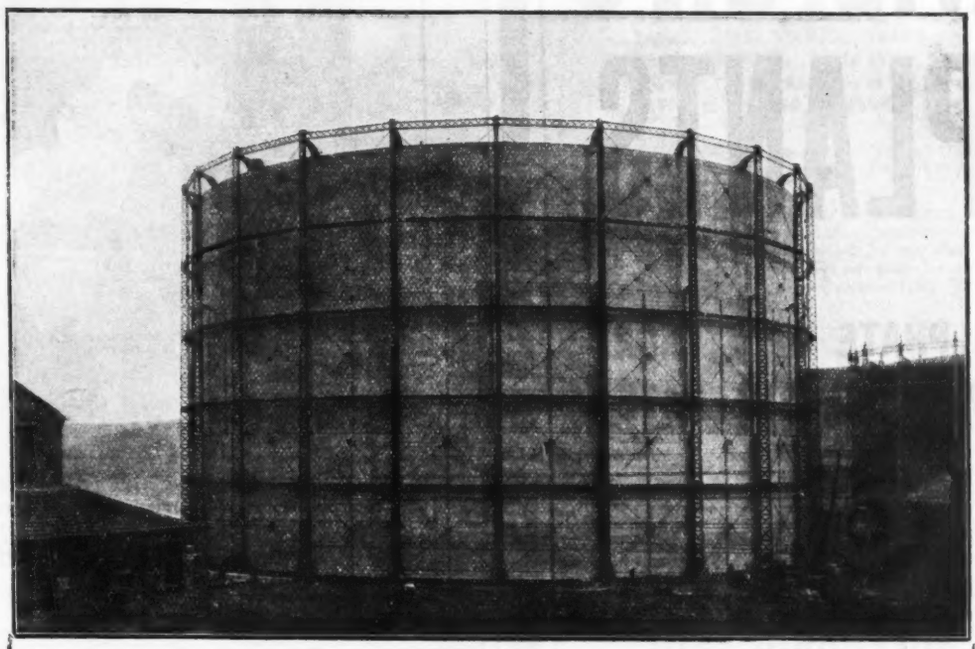

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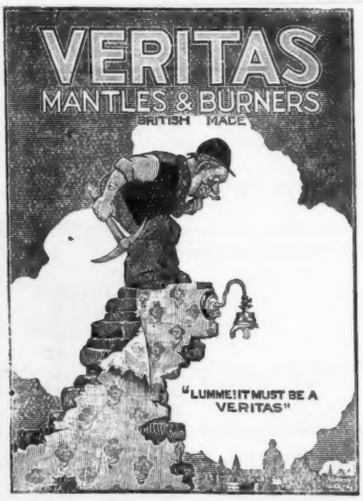

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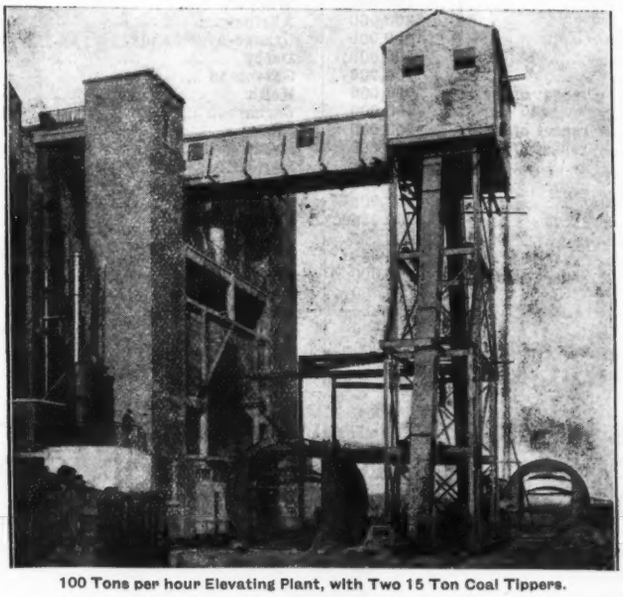

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Newark	1 „	300,000
Henley	1 „	150,000
East Grinstead	1 „	200,000
Sandown	1 „	100,000
Grantham	1 „	300,000
Heywood	1 „	300,000
Normanton	2 „	100,000
Enniskillen	1 „	50,000
Llandudno	1 „	300,000
Swadlincote	1 „	200,000
Irthlingborough	1 „	100,000
Knottingley	1 „	100,000
Newcastle, Staffs	1 „	300,000
Conway	1 „	100,000
Burnham	1 „	75,000
Burntisland	1 „	200,000
Bridgend	1 „	100,000
Limerick	1 „	300,000
Colwyn Bay	1 „	300,000
Carmarthen	1 „	100,000
Kirkby in Ashfield	1 „	100,000
Kelso	1 „	100,000
Otley	1 „	100,000
Blandford	1 „	100,000
Grange & Cartmel	1 „	100,000
Tiverton	1 „	100,000
Formby	1 „	100,000
Kidderminster	2 „	600,000
Tonbridge	1 „	500,000
Larne	1 „	100,000
Kelty	1 „	150,000
Horley	1 „	150,000
East Dereham	1 „	100,000
Aberystwith	1 „	200,000
Harpenden	1 „	300,000
Kildwick	1 „	200,000
Haslemere	1 „	150,000
Southbank	1 „	300,000
Mirfield	1 „	300,000
Whitby	1 „	300,000
Featherstone	2 „	100,000
Guernsey (repeat order)	1 „	500,000
Thirsk	1 „	100,000
Newark (repeat order)	1 „	300,000
Llandudno (repeat order)	1 „	300,000
Hexham	2 „	150,000
Selby	2 „	150,000
Wellington (Salop)	1 „	200,000
Portheawl	1 „	200,000
Teignmouth	1 „	200,000
Letchworth	2 „	300,000
Colwyn Bay (repeat order)	1 „	300,000
Whitstable	1 „	100,000
Cordoba	1 „	200,000
Yeovil	1 „	200,000
Jersey (repeat order)	1 „	300,000

		Cub. ft. per 24 hours.
Dursley	2 Set	150,000
Cirencester	1 „	100,000
Goring-on-Thames	1 „	75,000
Grays & Tilbury	2 „	300,000
Castleford	1 „	300,000
Haverton Hill-on-Tees	2 „	100,000
Batley	2 „	300,000
Haslingden	1 „	200,000
Ossett	1 „	300,000
Seaton	2 „	75,000
Tayport	1 „	75,000
Ryde, Isle of Wight	2 „	150,000
Knottingley (repeat order)	1 „	100,000
Newquay	2 „	75,000
Pontefract	2 „	200,000
Congleton	1 „	200,000
Fleetwood	1 „	300,000
Prestonpans	2 „	100,000
Plymouth	2 „	500,000
Cork	1 „	300,000
Selkirk	1 „	150,000
Morley	1 „	200,000
Sheffield	2 „	500,000
Bathgate	1 „	150,000
Littleborough	1 „	200,000
Newport, Isle of Wight	1 „	150,000
Scunthorpe	2 „	300,000
Langley Mill	1 „	300,000
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Walton-on-Thames	2 „	150,000
Kettering	1 „	300,000
Bishop Auckland	2 „	150,000
Draycott	1 „	200,000
Bedford	2 „	750,000
Colne	1 „	500,000
Musselburgh	1 „	300,000
Ambleside	1 „	100,000
Leyland	2 „	200,000
Wisbech	1 „	150,000
Altrincham	2 „	200,000
Grange-over-Sands (repeat order)	1 „	100,000
Derby	1 „	500,000
Gravesend	1 „	300,000
Keith	1 „	50,000
Carnarvon	1 „	300,000
Elland	2 „	300,000
Hemsworth	1 „	100,000
South Elmsall	1 „	100,000
Hindley	2 „	300,000
Abercarn	1 „	150,000
Grangemouth	1 „	200,000
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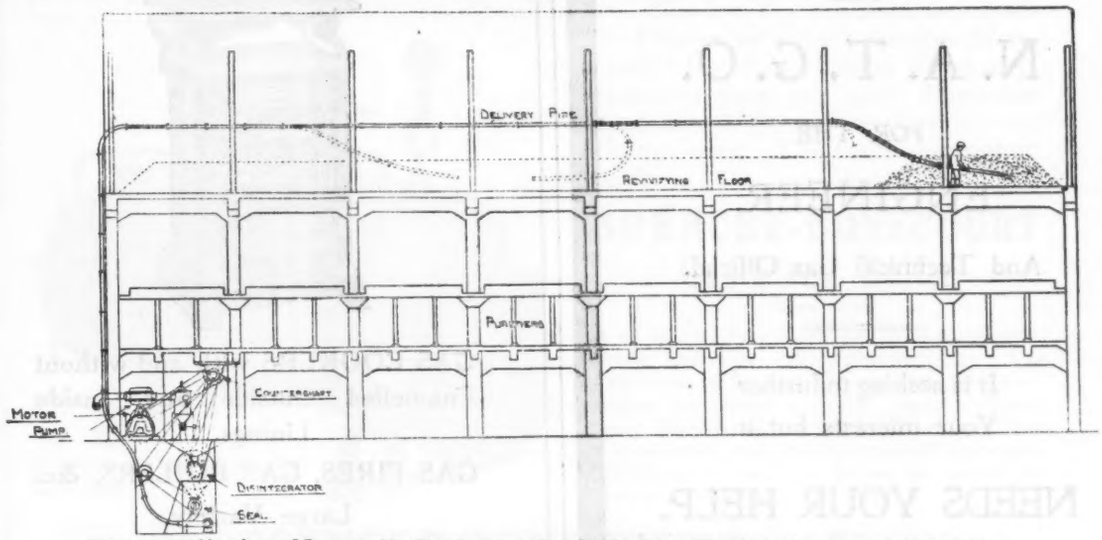

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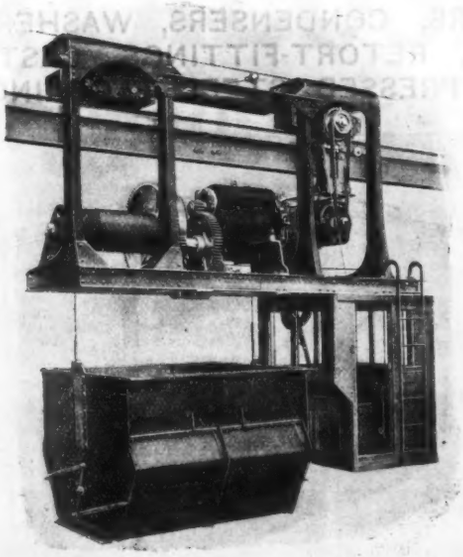

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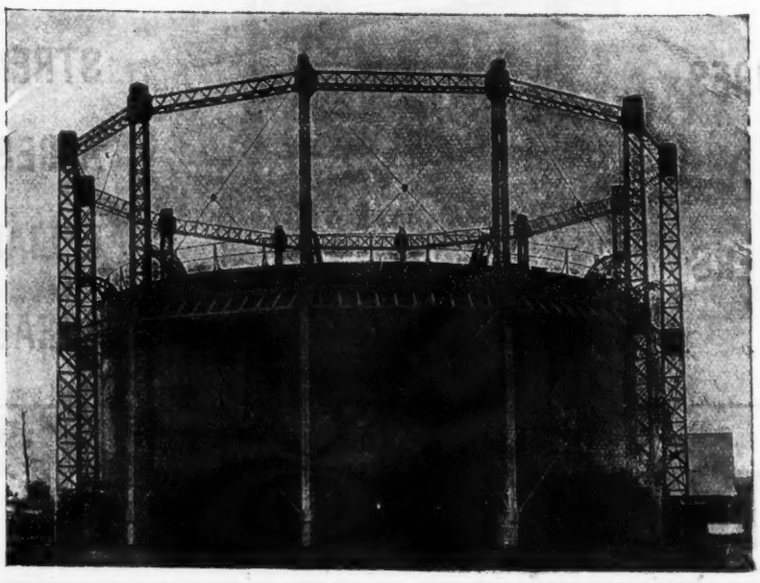

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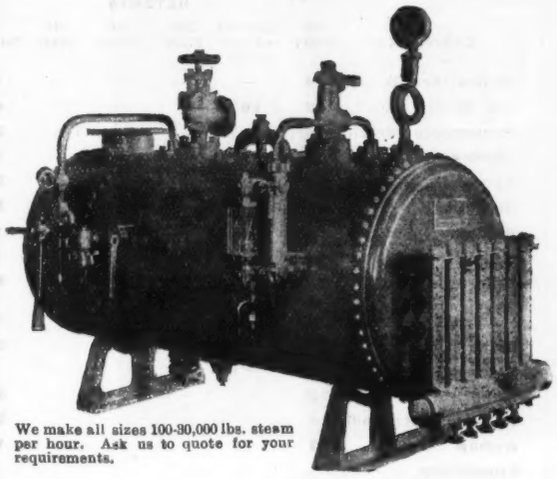

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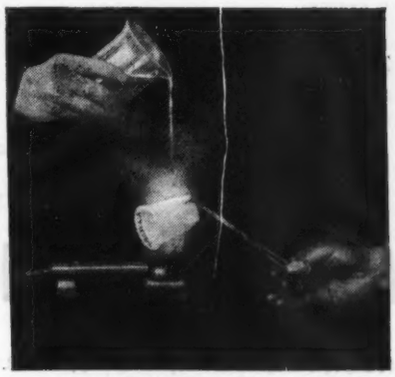
Vitreosil can be made white hot and quenched in cold water. *Photograph shows this drastic test being applied.*



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London Depot: 28, Victoria Street, S.W.1.

GLOVER-WEST VERTICAL RETORTS

INSTALLATIONS AND NUMBERS OF RETORTS.

CASWORKS.	1st Plant	Extension to retort bench	2nd Plant	3rd Plant	4th Plant	Totals
St. Helens	8	—	40	*48	—	96
Manchester	16	—	128	*128	—	272
Rochdale	40	—	—	—	—	40
Tokio (Japan)	56	—	—	—	—	56
Lurgan	8	—	—	—	—	8
Helensburgh	16	—	—	—	—	16
Sydney	56	—	56	160	*224	496
Bradford	64	—	—	—	—	64
Fitchburg (U.S.A.)	8	—	8	—	—	16
Newcastle (N.S.W.)	32	—	—	—	—	32
Belfast	80	—	160	—	—	240
Nelson	40	—	40	—	—	80 *
Blackpool	24	—	24	—	—	48
Stockholm (Sweden)	48	—	—	—	—	48
Bergen (Norway)	24	—	—	—	—	24
Newcastle-upon-Tyne	80	—	96	—	—	176
Heywood	16	—	—	—	—	16
Darlington	64	—	—	—	—	64
Oldham	64	—	—	—	—	64
Bridgwater	20	—	—	—	—	20
Southport	40	—	—	—	—	40
Cambuslang	16	—	—	—	—	16
Nottingham	48	—	—	—	—	48
Tipton	16	—	—	—	—	16
Leicester	80	32	*64	—	—	176
Exeter	40	—	*32	—	—	72
Barnoldswick	16	*8	—	—	—	24
Goteburg (Sweden)	32	—	*40	—	—	72
Cape Town (South Africa)	16	—	*24	—	—	40
Hongkong (China)	24	—	—	—	—	24
Berlin (Germany)	8	—	—	—	—	8
Liverpool	64	—	64	—	—	128
Macclesfield	32	—	—	—	—	32
Lytham	16	—	—	—	—	16
Dunoon	12	—	—	—	—	12
Montreal (Canada)	112	—	*64	*64	—	240
Pawtucket (U.S.A.)	32	—	—	—	—	32
Ottawa (Canada)	48	—	—	—	—	48
Grays and Tilbury	16	—	—	—	—	16
Bangor (Ireland)	12	*8	—	—	—	20
Brisbane (Queensland)	48	—	—	—	—	48
Northampton	32	—	32	*32	—	96
Cardiff	80	—	*40	—	—	120
North Sydney (N.S.W.)	80	—	—	—	—	80
Uddingston	24	—	—	—	—	24
Springfield (U.S.A.)	48	—	—	—	—	48
Preston	32	—	*32	—	—	64
Portland (U.S.A.)	32	—	—	—	—	32

INSTALLATIONS AND NUMBERS OF RETORTS

CASWORKS.	1st Plant	Extension to retort bench	2nd Plant	3rd Plant	4th Plant	Totals
Santos (Brazil)	24	—	—	—	—	24
Lea Bridge	32	*16	—	—	—	48
Pernambuco (Brazil)	24	—	—	—	—	24
Chorley	32	—	—	—	—	32
Swindon	16	*8	—	—	—	24
Rochester	32	—	—	—	—	32
Rothesay	12	—	—	—	—	12
Napier (New Zealand)	16	—	—	—	—	16
Salford	40	—	—	—	—	40
Rhymney and Aber Valleys	16	—	—	—	—	16
Blyth	32	—	—	—	—	32
Holywood	6	—	—	—	—	6
Stafford	32	—	—	—	—	32
Zaandam (Holland)	24	—	—	—	—	24
Wishaw	12	—	—	—	—	12
Copenhagen (Denmark)	—	—	—	—	—	—
Palmerston (N.Z.)	*16	—	—	—	—	16
H.M. Fuel Research	*4	—	—	—	—	4
Stratford (Gas Light and Coke Co.)	*80	—	—	—	—	80
Romford	*16	—	—	—	—	16
Dublin	*64	—	—	—	—	64
Coatbridge	*32	—	—	—	—	32
Denton	*16	—	—	—	—	16
Port Glasgow	*12	—	—	—	—	12
Norwich	*80	—	—	—	—	80
Falkirk	*32	—	—	—	—	32
Blackburn	*96	—	—	—	—	96
Montrose	*8	—	—	—	—	8
Bury	*40	—	—	—	—	40
Alexandria (Vale of Leven)	*16	—	—	—	—	16
Coventry	*72	—	—	—	—	72
Carlisle	*64	—	—	—	—	64
Ballymena	*8	—	—	—	—	8
Victoria (British Columbia)	*16	—	—	—	—	16
Vancouver (British Columbia)	*24	—	—	—	—	24
Reading	*40	—	—	—	—	40
Leeds	*72	—	—	—	—	72
Dumbarton	*16	—	—	—	—	16
Wellington (N.Z.)	*48	—	—	—	—	48
Leigh (Lancs.)	*4	—	—	—	—	4
Perth (Scotland)	*32	—	—	—	—	32

Total Number of Retorts ... 4,750

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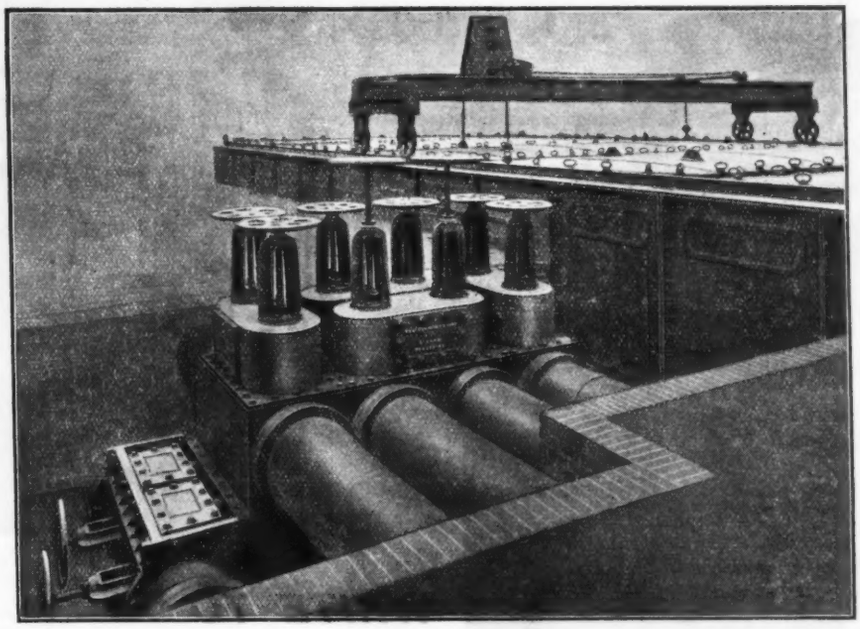

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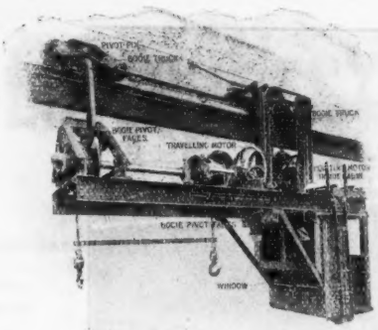

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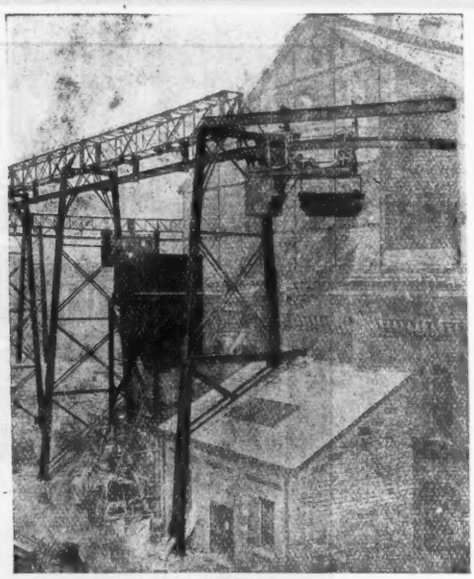

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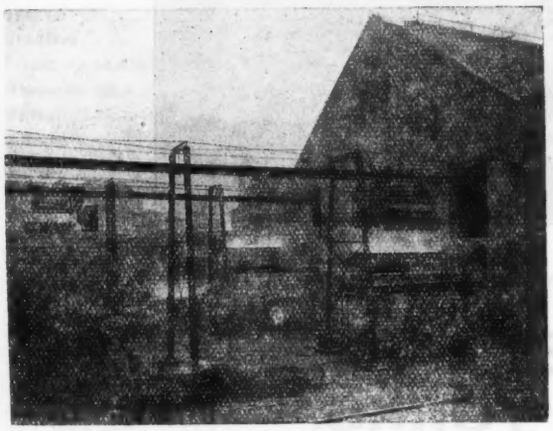

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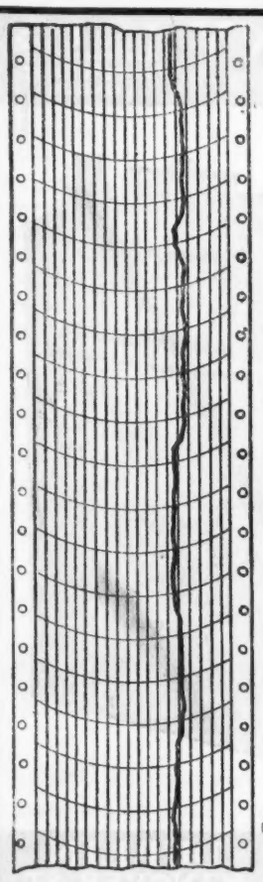

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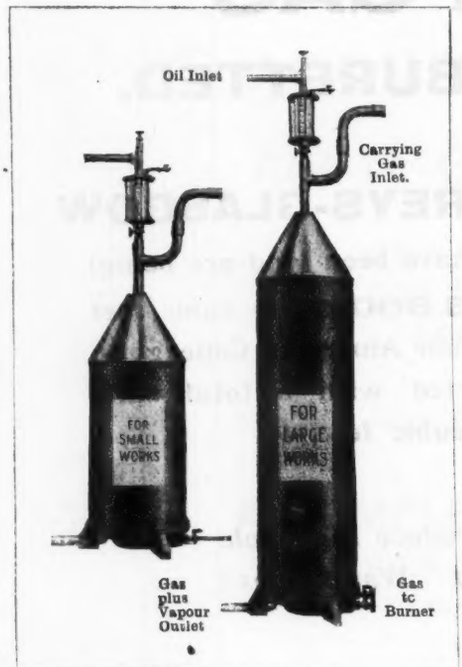

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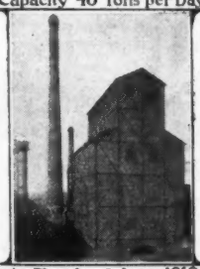

Order Placed 3 June 1919
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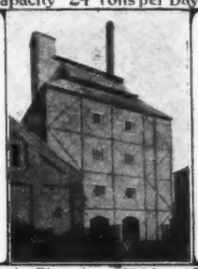

Order Placed 27 May 1919
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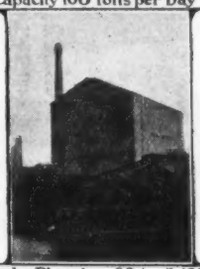
Capacity 100 Tons per Day



Order Placed 30 April 1919
Gas Making Commenced 15 Oct 1920

RIPON
Capacity 40 Tons per Day

Order Placed 30th April 1919
Gas Making Commenced 20th Nov 1920

CARNOUSTIE
Capacity 21 Tons per Day

Order Placed 23rd Dec 1919
Gas Making Commenced 4th Dec 1920

WEXFORD
Capacity 18 Tons per Day

Order Placed 22nd Nov 1919
Gas making commenced 15th April 1921

	Capacity per Day	Order Placed	Gas Making Commenced
NEWTON-IN-MAKERFIELD (Extension)	21 Tons	4th April 1919	9th Aug 1920
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WORKINGTON (Extension)	23 Tons	20th Feb 1920	10th Jan 1921

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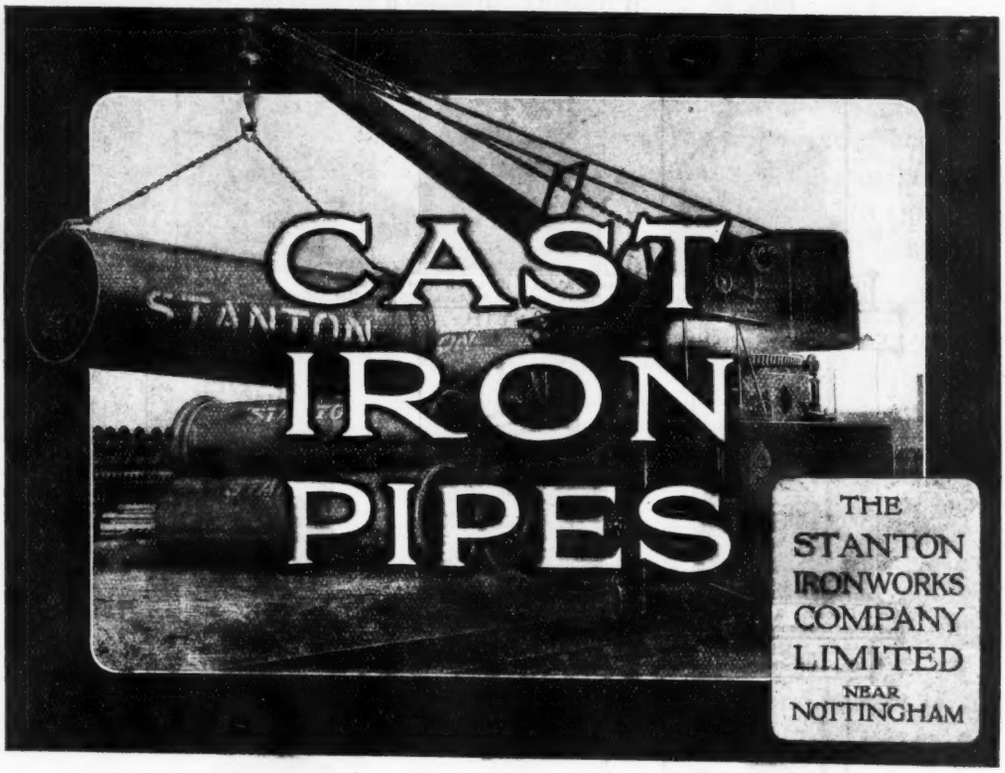
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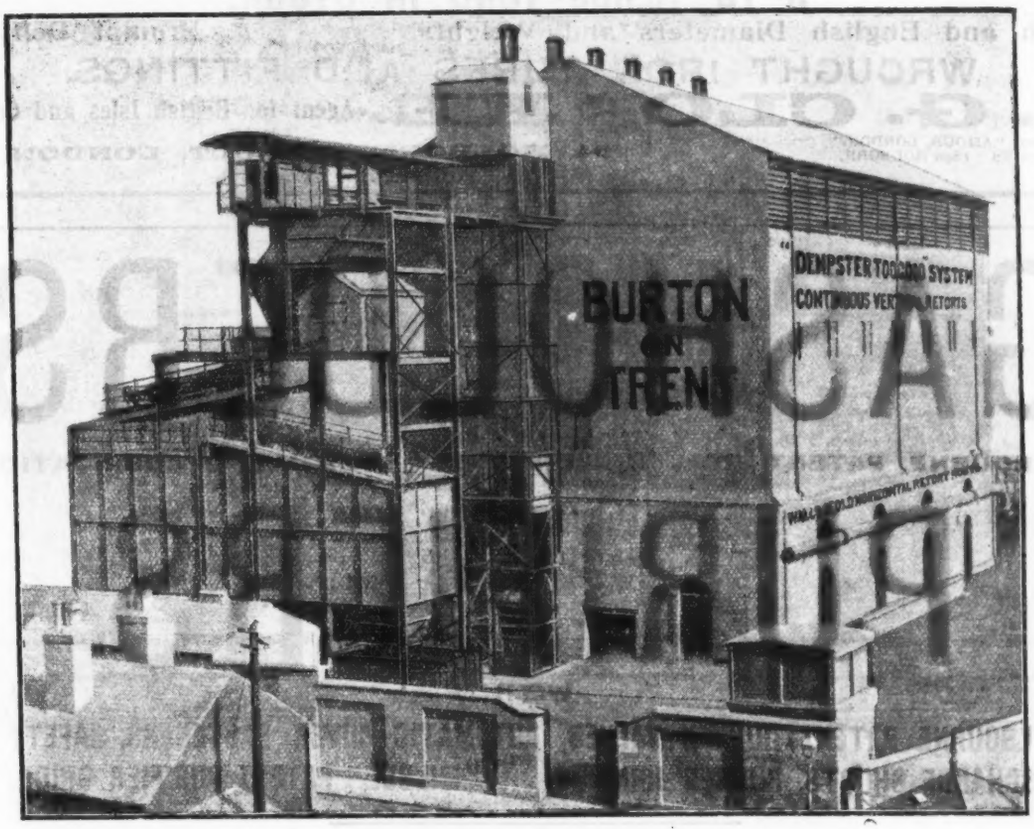

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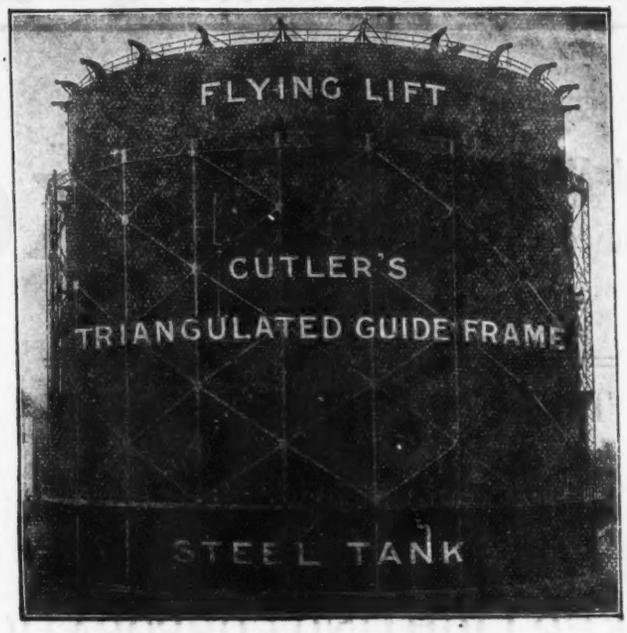

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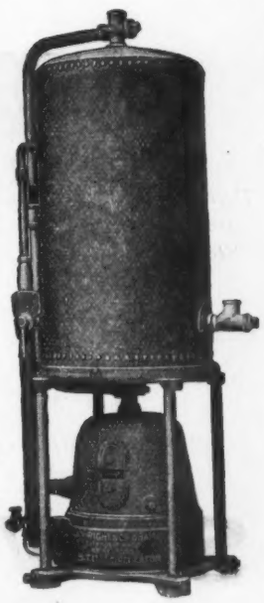

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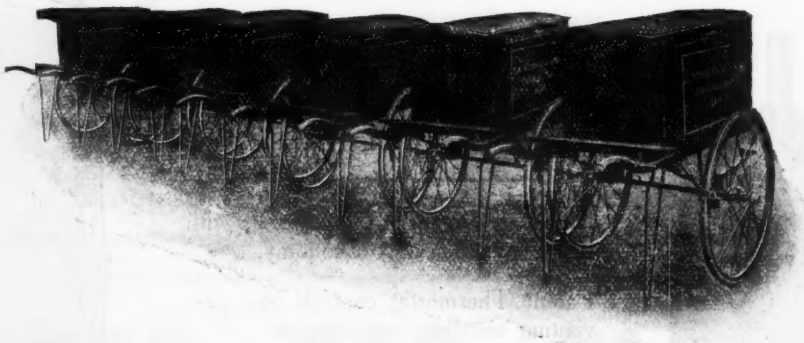

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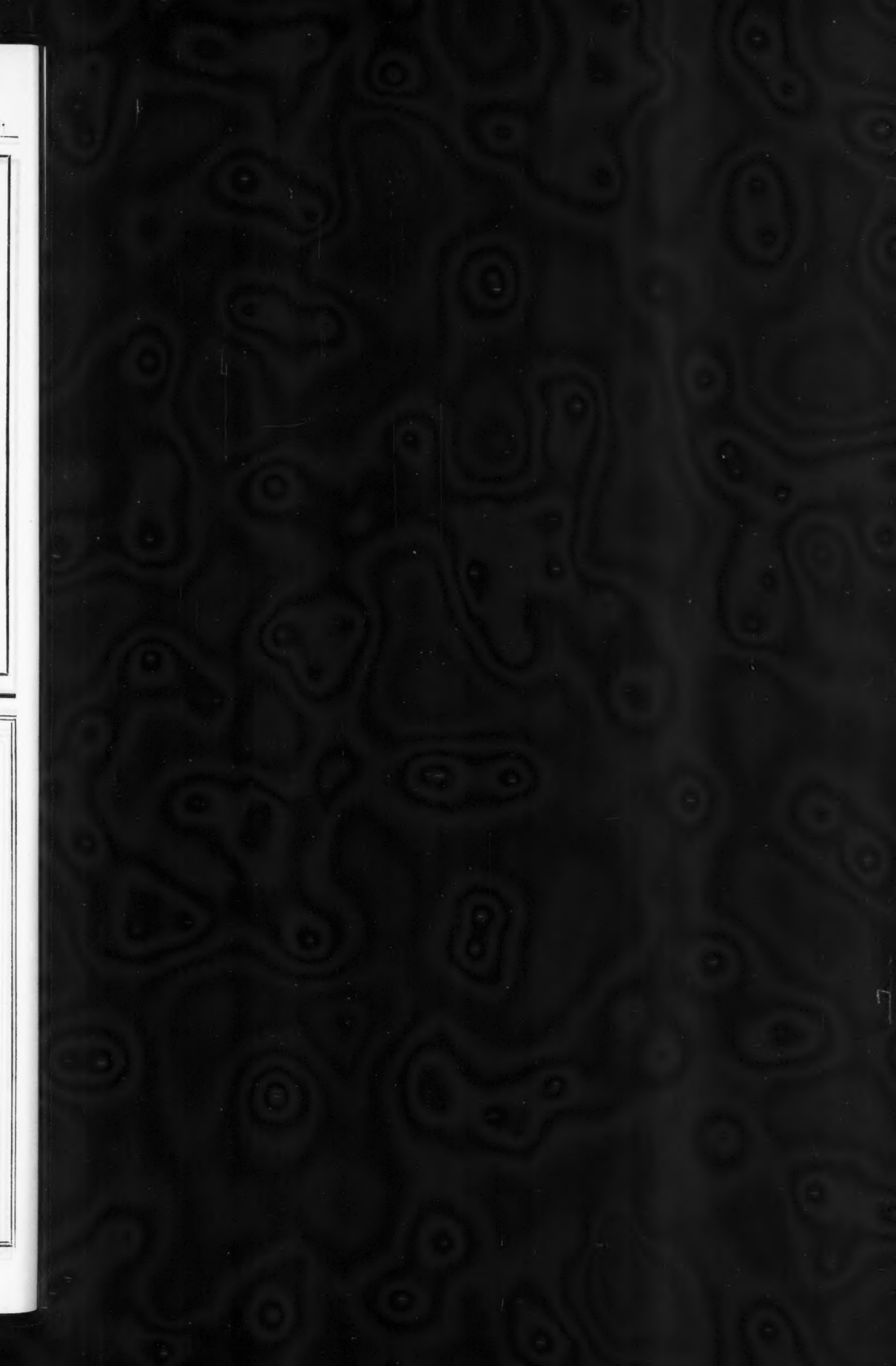

ROBERT DEMPSTER & SONS, Ltd., ELLAND, Gas Engineers and Contractors for CARBONIZING PLANTS on Horizontal or Vertical Principles, and Stoking Machinery. HANDLING INSTALLATIONS, including Coal Breaking, Elevating, Conveying Plants and Coke Screening, Storing and Telpherage Plants. PURIFICATION.—All Branches of Wet and Dry Purification. STORAGE.—Gasholders, and all forms of Gas Apparatus. Wire: "DEMPSTER, ELLAND." 'Phones: ELLAND 261, 262, 265.

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(GAS DEPARTMENT.)

TENDERS are invited for the Supply of GENERAL STORES:—

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2.—CAST-IRON MAIN PIPES and CONNECTIONS.
3.—IRON CASTINGS.
4.—WROUGHT-IRON GAS and STEAM TUBING and FITTINGS.
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9.—LEAD PIPE.
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12.—PAINTS.
13.—BRUSHES.
14.—TIMBER.
15.—MAINTENANCE and REPAIRS of WEIGHING MACHINES.

Full Particulars may be obtained on Application to the Gas Engineer, Gas Offices, Bloom Street, Salford.

L. C. EVANS,
Town Clerk.

EDINBURGH CORPORATION.

(GAS DEPARTMENT.)

ASH-HANDLING PLANT.

THE Corporation are prepared to consider TENDERS for an ASH-HANDLING PLANT to Deal with a Maximum of 100 Tons of Rough Furnace Ashes per Day. The Plant must be capable of Recovering all usable Fuel of all Grades and Delivering the Debris in Graded Sizes suitable for Concrete Making or other purposes.

Drawings, Specifications, Prices, and Full Particulars to be addressed to the undersigned on or before Saturday, July 23. The Engineer and Manager of the Gas Department will Supply any additional Information required, and make Arrangements for Visiting the Works if desired.

The Corporation do not bind themselves to accept the lowest or any Tender.

A. GRIERSON, S.S.C.,
Town Clerk.

City Chambers, Edinburgh,
June 20, 1921.

GAINSBOROUGH URBAN DISTRICT COUNCIL.

(GAS DEPARTMENT.)

TENDERS FOR AMMONIACAL LIQUOR.

THE Gas Committee of the above Council invite TENDERS for the Purchase of the AMMONIACAL LIQUOR produced at their Works for a period of Six and Twelve Months, from 1st July, 1921.

The Ammoniacal Liquor will be Delivered into Contractor's Tank Barrels at the Works.

Sealed Tenders, endorsed "Tender for Ammoniacal Liquor," addressed to the Chairman of the Gas Committee, must be Delivered at the Gas-Works, Gainsborough, not later than the 2nd of July, 1921.

The Committee do not bind themselves to accept the highest or any Tender.

JOHN BALDWIN,
Engineer and Manager.

Gas-Works, Gainsborough,
June 21, 1921.

CORPORATION OF DUBLIN.

(PUBLIC LIGHTING COMMITTEE.)

TENDERS FOR STANDARD TEST GAS-METER.

THE Public Lighting Committee of the Corporation of Dublin are prepared to receive TENDERS for the Supply of one 100-Light Portable Standard TEST GAS-METER.

Specification and Form of Tender may be obtained from the Official Inspector of Gas-Meters, Public Lighting Department, Tara Street, Dublin, on payment of the sum of One Guinea, which will be refunded on receipt of a *bona-fide* Tender.

Tenders, sealed and endorsed "Tender for Gas-Meter," to be addressed to "The Chairman, Public Lighting Committee, 15, Parliament Street, Dublin," and to be Delivered so as to reach the Committee's Offices not later than Twelve Noon on Friday, the 15th of July, 1921.

The Committee do not bind themselves to accept the lowest or any Tender.

FRED J. ALLAN,
Secretary.

Public Lighting Committee's Offices,
15, Parliament Street, Dublin,
June 25, 1921.

CARBONIZATION PLANT.

THE Lurgan Urban District Council are prepared to receive TENDERS for—

1.—The Supply and Erection Complete of a WATER GAS or TOTAL CARBONIZATION PLANT sufficient to Produce 300,000 c.ft. of Gas per Twenty-four hours.

2.—Supply and Erection of STEEL FRAME CORRUGATED BUILDING to Cover Same.

Plans and Specification to be submitted with separate Tenders for above before July 16, 1921.

Forms of Tender and Further Information as to Site, &c., can be obtained on application to W. Tallentire, Engineer and Manager, Gas-Works, Lurgan.

The Lowest or any Tender not necessarily accepted.

F. W. POLLOCK,
Town Clerk.

Lurgan,
June 24, 1921.

COMPANY NOTICES.

COMMERCIAL GAS COMPANY.

NOTICE is Hereby Given that the TRANSFER BOOKS of this Company, SO FAR AS THEY RELATE TO CAPITAL STOCKS, WILL BE CLOSED from the 6th of July to the 5th of August, both days inclusive, and that Dividends will be paid on the 15th of August next to the holders registered at the date of the closing.

By order of the Board,
F. J. BRADFIELD,
Secretary.

Offices: Stepney, E. 1,
June 16, 1921.

STOCKS AND SHARES.

By Order of the Directors.

NEW ISSUE OF CAPITAL.

REDHILL GAS COMPANY.

(Incorporated by Special Act of Parliament, 1865.)

MESSRS. A. & W. RICHARDS are Instructed to issue

£20,000 7½ PER CENT. REDEEMABLE DEBENTURE STOCK.

Issue Price, Par.
To be Redeemed at Par on July 1, 1931.

The Net Revenue of the Company for the year ended 31st of December last was £10,919 6s. 4d., and as the Interest on the Debenture Stock, including that now being issued, only requires £2696, the Stock constitutes an excellent security.

The Company's sales of Gas in 1914 were 141 Million Cubic Feet; last year they had risen to upwards of 180 Millions.

Prospectus and Form of Application (which must be sent in by 11 o'clock on Thursday, 7th of July) may be obtained of Messrs. A. & W. RICHARDS, 37, WALBROOK, E.C. 4. (Telephone: City 3333.)

ISSUE BY THE

WESTON-SUPER-MARE GASLIGHT COMPANY

OF

£23,340 7½% PERPETUAL DEBENTURE STOCK

AND

£10,856 7½% PREFERENCE STOCK.

Full Particulars, Prospectus, and Application Form may be obtained from

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Gas Engineers' Agents and Contractors for METERS, FIRE-CLAY GOODS, OXIDE OF IRON, AND ALL OTHER GAS APPARATUS.

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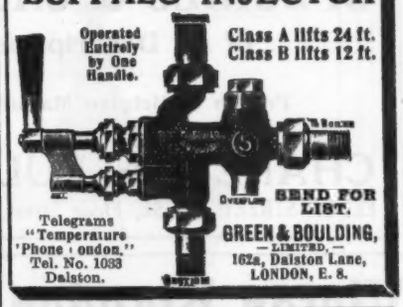

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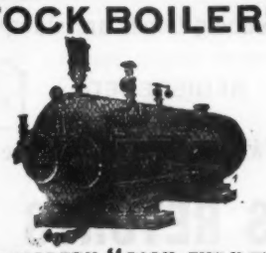

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Five	28 ft. 0 in. × 7 ft. 6 in. × 120 lbs. W.P.
Four	28 ft. 0 in. × 7 ft. 3 in. × 160 lbs. W.P.
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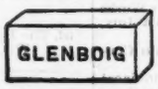
TRADE 

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Cast Brass PRE-HEATED INVERTED BURNER.

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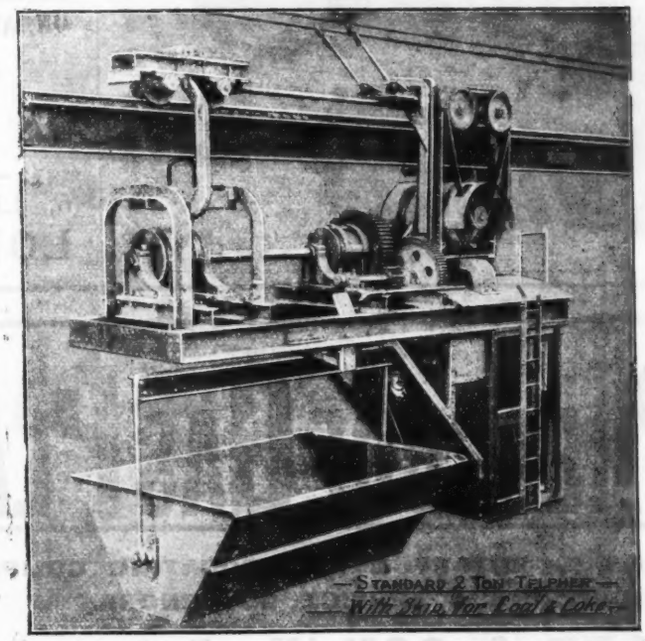

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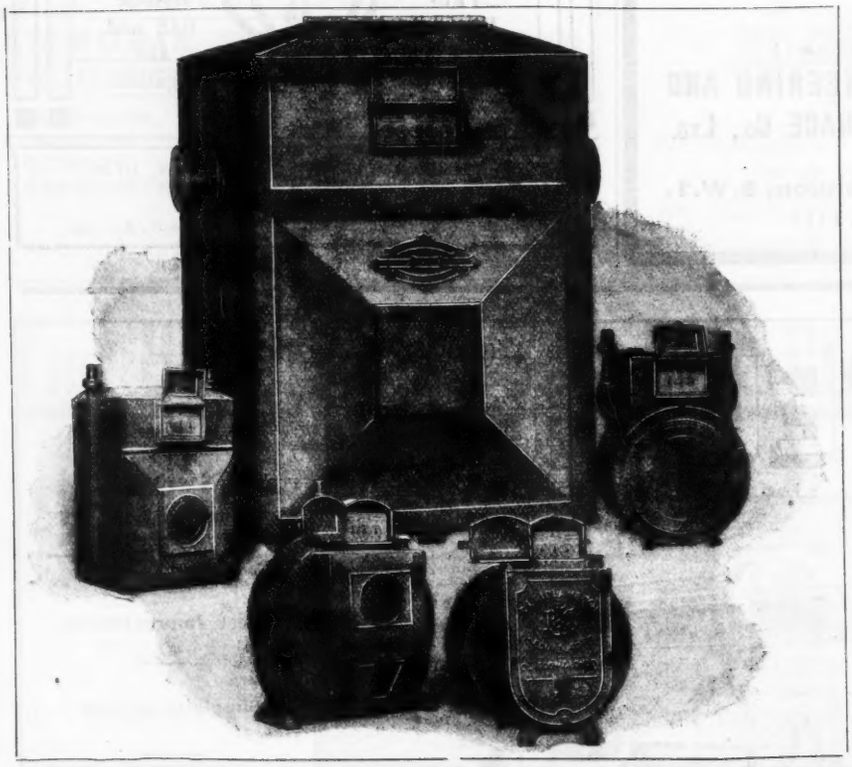

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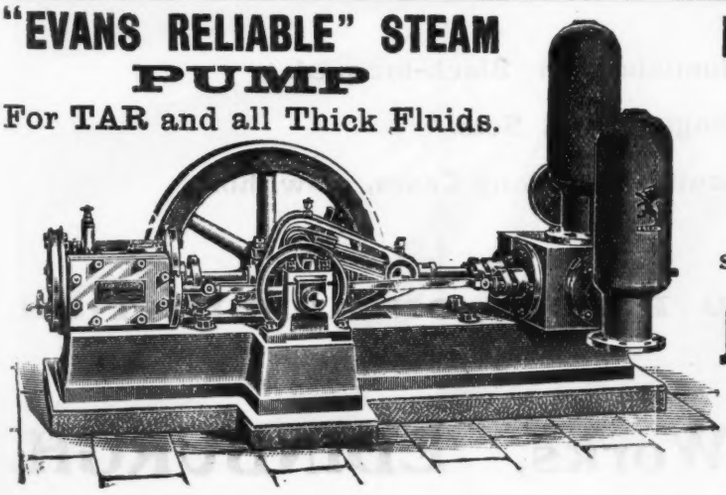

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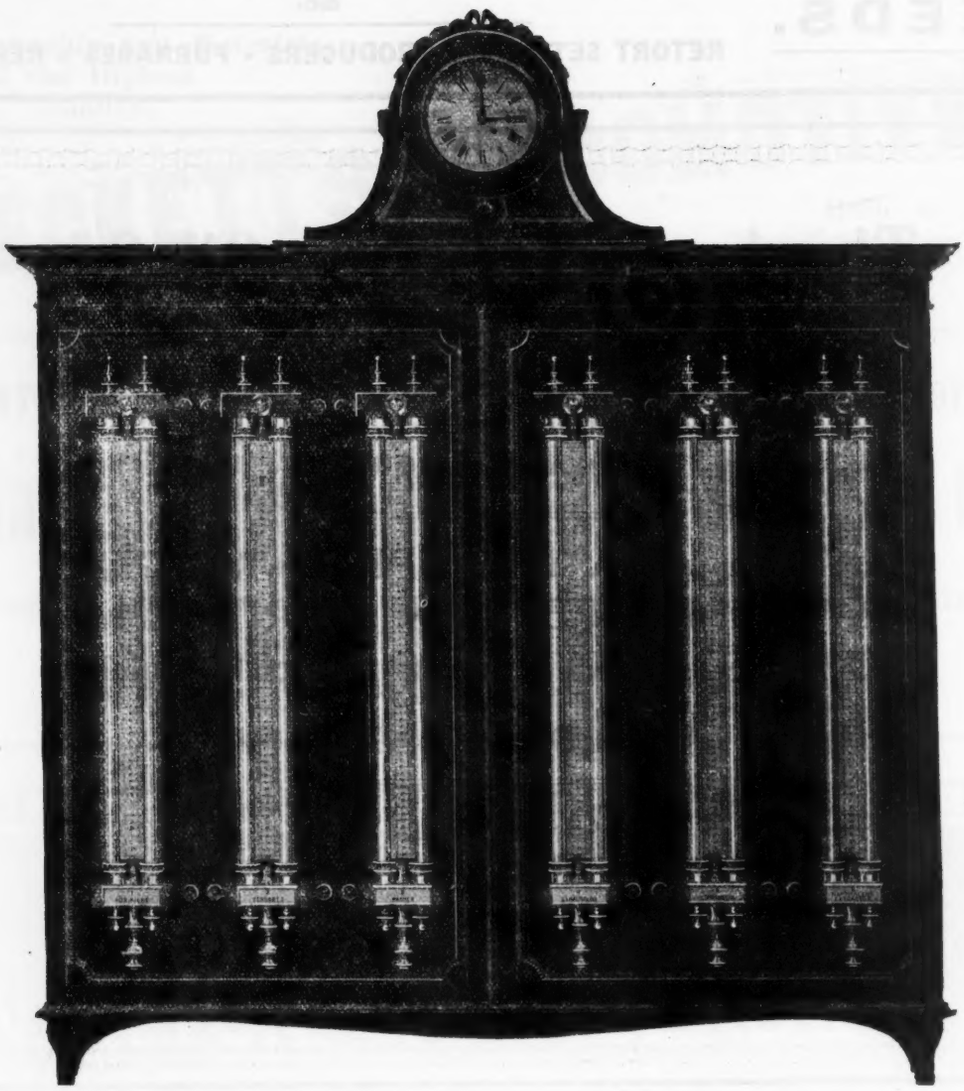

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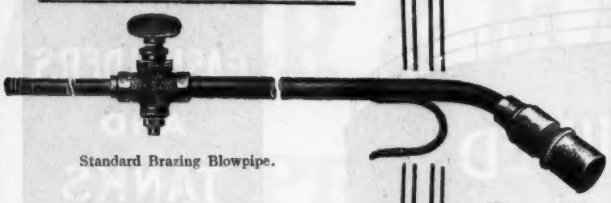

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Blowpipe with pre-heated needle-pointed flame

FURNACE for heating small articles to a high temperature. A useful appliance in the Tool Room.

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A SUCCESSFUL MECHANICAL DEVICE WHICH PUTS A BIG 12-HOUR CHARGE IN HORIZONTAL RETORTS.

WE FILL THE RETORT BY A SIMPLE MECHANISM

WHICH

(1) Lays a full charge of coal in position without dust or noise.

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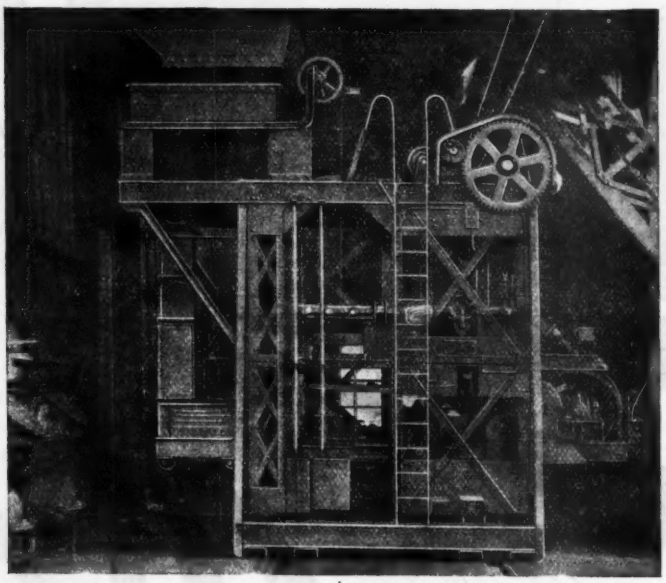

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IMPROVED COKE.
REDUCED LABOUR COSTS.

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LOW FIRST COST: As charging and discharging mechanism is in one.

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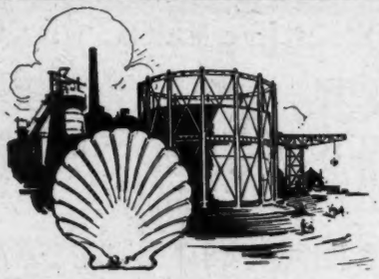

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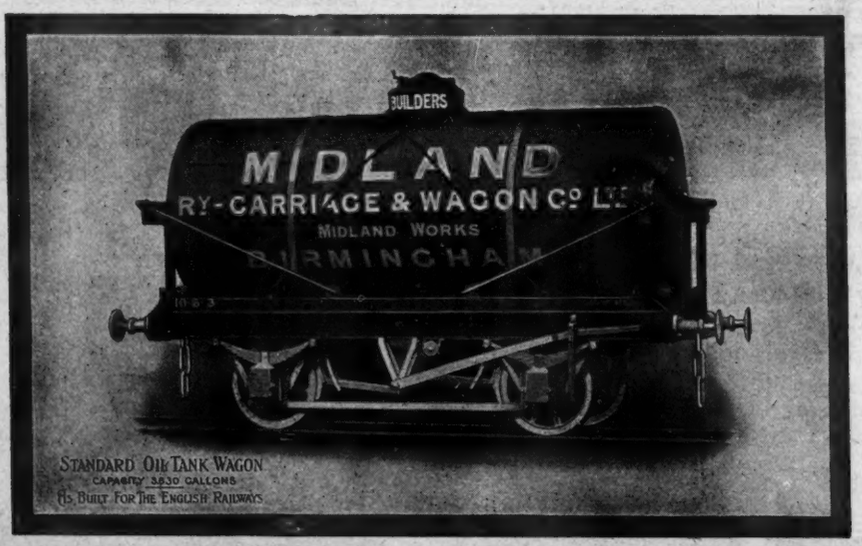

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